

**EPIGENETIC ROOTED ARCHITECTURE**  
**A TYPOLOGY FOR OBSTETRICAL PROGRAMMING**

by

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of the requirements for the degree of  
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## ABSTRACT

Western medicine has involved studies of environmental, social, and dietary stress that leads to the diagnosis of hereditary disorders. Even with pharmaceutical treatments, these disorders have risen. This short-term response does not benefit the long-term health of future generations. By refocusing with theories of “survival of the fittest,” adaptation starts when an individual perceives and responds to their built environment. Personal senses (vision, smell, touch, taste, etc.) gather information on a specific space and are subsequently expressed through an emotional response. This internal process, called the limbic system, is done through hormones that respond to sensory/emotional information and give function to cells through the body. Disorders arise when there is too much or too little of a hormone that damages how the body reads the DNA within a cell, known as an epigenetic modification. The misreading and re-interpretation of epigenetic patterns are most crucial during exponential cell growth during *in utero*. Therefore, the architectural reading of an expecting mother may hinder or benefit the unborn child’s future health. *How can we use the built environment to promote human’s fitness within the timeframe of in utero?*

Architecture can display multiplicities of emotional responses. Theories in biophilic design and cognitive architecture have listed multiple architectural elements and their spectrum of emotions. This information can be used at its full capacity when starting at the micro responses of cells due to macro atmospheric qualities. When imposing a new typology for pregnant women, their health and programmatic requirements connect to architectural elements, emotions, and senses that start to inform a design toolkit. This will assist in the design and development of a short-term residence for pregnant and post-partum women who require a secure and stimulating architecture. This new typology will investigate the use of data as a means to generate a building that is self-aware of these interactions; creating a relationship between architecture and mother that is not one-sided but continuously responding to her changing needs.

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KEYWORDS [ *algorithms / architecture / cognitive / endocrine system / epigenetics / limbic system / maternal environment / medical / midwifery / new typology / obstetric / parturition / pregnancy / short-term residence / survival-of-the-fittest / women’s health / well-being* ]



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This thesis is dedicated to my family who I am eternally grateful for. For my father, who is my hero; and my mother, who I am an extension of. I thank you for your love and care for me, even before birth.



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# **I**

PART





## INTRODUCTION

“Man singled himself out from the rest of creation, believing himself subject to some ‘higher law’ to which implicit obedience was also ‘blind’. The work of Darwin cut the strings of this puppet-like suspension above the stage of the rest of creation. Now we recognize Man as but one of the species undergoing evolution in cosmos.”<sup>01</sup>

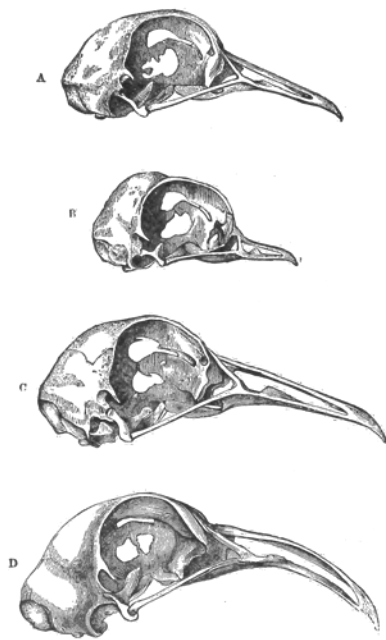
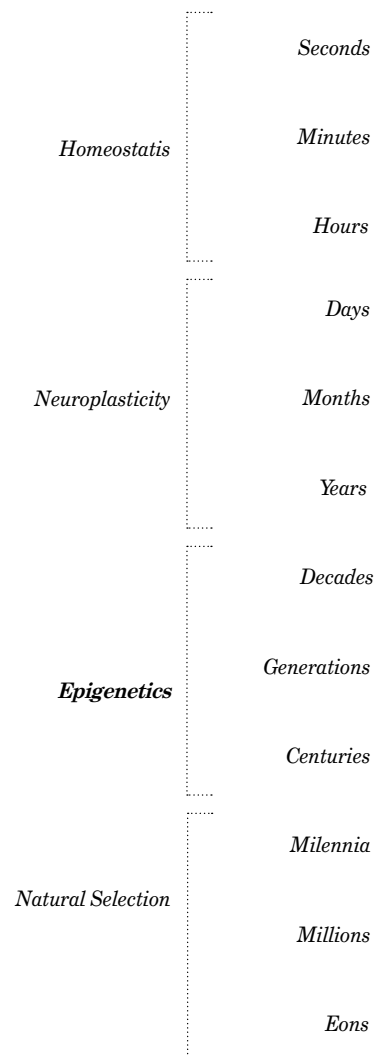


FIGURE [1]  
Darwin's Bird Skulls comparing multiple species and their form. These birds adapted to their environment for a particular place and time.

Pearse and Crocker wrote about the importance of not forgetting human's ubiquitous responses to the world in their medical programming experiments<sup>02</sup>. These responses directly affect our well-being and those of our future generations. This peak of interest cultivates the question of “*what influence does the built environment have on us, the human species, in our evolutionary development?*” To answer this question we start at the goal of life itself, which is survival. Referring to Charles Darwin's theory of “survival of the fittest”, life is involved in a natural selection process. In Darwin's book the *Origin of Species*, he specifies that our species were a result of adaptations to external factors, and those who could not adapt would not survive<sup>03</sup>. However, “survival of the fittest” is not a contest. It is not this perception that humans are superior to non-humans; it is that each species have developed specifically to adapt to a certain place and time [1]. Darwin writes, “like that of all parts, [...] every family is very unequal and totally lost, and in instances missing one part than the other, but plays a crucial role to that existence<sup>04</sup>.” Therefore, it is biased to compare segments and operations as each is a unique case that resulted due to many multiplicities.

How do we even begin to comprehend the contributions of our well-being by these multiplicities? There is imposed solutions that we need to eat better, be less stressed, and have healthier relationships; but we ignore the direct contact with the artificial landscape as a manifested trigger. Architecture has a spectrum of qualities that are but not limited to scale, light, materiality, and program. These infinite factors that interact with each other, and their different consequences, are what architects must consider during design. Deleuze and Guattari's *Thousand Plateaus* is a text that some architects refer to when attempting to comprehend the conjunction of these multiplicities. Their book is a philosophy of looking at the world as a rhizome that develops a language of patterns, and when connecting the “intensities of multiplicities” they result in a web with no beginning or end<sup>05</sup>. This rhizome contributes to the theory of Darwin's evolution as it was not a single thing that made humans

FIGURE [2]  
*Human Responses' Timeframe, as described by David Shenk, displays a window of time for epigenetic modifications.*



the way we are today, but an unexplained intertwining of these multiplicities<sup>06</sup>. Architects have used these interconnections as a methodology to their work, such as Christopher Alexander's text, *Pattern Language*, and Peter Eisenman's graphical representation<sup>07</sup>. Both are applicable design processes that uses abstract patterns of humans and nature.

Applying this language appropriately to design will show the patterns of architecture to human evolution. Instead of applying to the scale of millennia in natural selection, there is a generational timeframe where we see these effects on our well-being within a lifetime. Between the human responses' timeframe, there is a window of time between neuroplasticity and natural selection that contributes to the epigenetic changes of our body<sup>08</sup> [2]. Epigenetics translates to "above the genome" and is how the body reads our DNA into the specific function that every compound/cell/organ needs<sup>09</sup>. These DNA translators are intertwined with our chromosomes and act as switches that turn on/off what is required (e.g., liver cells turn on liver cell functions and turn off what muscle cells needs). Essentially epigenetics is the software that reads the hardware of our DNA<sup>10</sup>. Throughout a lifetime, these switches turn on/off to transform the cells' functions for our adaption to an internal or external environment. The turning on/off of these functions are natural; however, it becomes a concern to "survival of the fittest" when these cells adapt incorrectly; resulting in physical and mental disorders<sup>11</sup>. In some cases, these are hereditary because some switches do not reset to perfect health and therefore affect future children<sup>12</sup>. This field of medicine is proof to believe that nature and nurture play both significant roles in how we are today.

These epigenetic triggers are correlated to the endocrine system as it becomes the chemical connection from the human's external stimuli to the cell receptors of that response. Evidence has connected epigenetics with dietary, social, and natural environment triggers (e.g., drastic temperature changes<sup>13</sup>). There is a lack of recorded medical investigations of endocrine triggers of architectural features, most likely due to the subjective measuring of an architectural intensity. However, there are theories to link the medical and architectural field. Before this, it is crucial to understand what

program would benefit if an architectural intervention were to take place. The most critical stage of genetic development, when internal and external factors have the most influence, is in utero<sup>14</sup>. Therefore, it is not only prenatal vitamins expecting mothers need to be vigilant for, but virtually the architectural features susceptible to her. Today's contemporary setting for childbirth is the maternity ward in western medicine hospitals<sup>15</sup>. Parturition is within the scope of epidemiology and less of a natural occurrence of humans and non-humans<sup>16</sup>. The ability to intervene the duration of a pregnancy with a new typology, that aims to be a short-term residence for those women and their support system, would be able to oversee the time when epigenetics plays a significant role on future generational health [3].

Exposures of the built environment and neurological triggers are associated with biophilic, phenomenology and cognitive architectural theory. Links of keywords with emotional well-being (i.e., safe, stress, control, arousal, boredom) connect the input of responses to our perception of architecture to the output of epigenetic switches. Architect Juhani Pallasmaa has written about the association of architecture to neuro-responses that has been a consideration to our evolutionary development<sup>17</sup>. Anthropological evolution research also provides further comprehension of epigenetic rules to behaviour towards the external environment<sup>18</sup>. The design process for this new typology begins by synthesizing thresholds of intensities in the relationships between the endocrine system, human behaviour, emotional responses, and architectural qualities. This rhizome can then be used to propose the architectural space and program of the linear sequence of a pregnancy.

In conclusion, we are whom we are today due to billions of years of life adapting to its environment. Architecture has a say in strengthening (or weakening) our development. The goal is not strategizing a way to produce the perfect person genetically, but produce a healthy environment that allows everyone coming into this world every opportunity for their future years. In doing so, we can lower disease and the reliance on pharmaceutical medicines to elevate the well-being of our species.

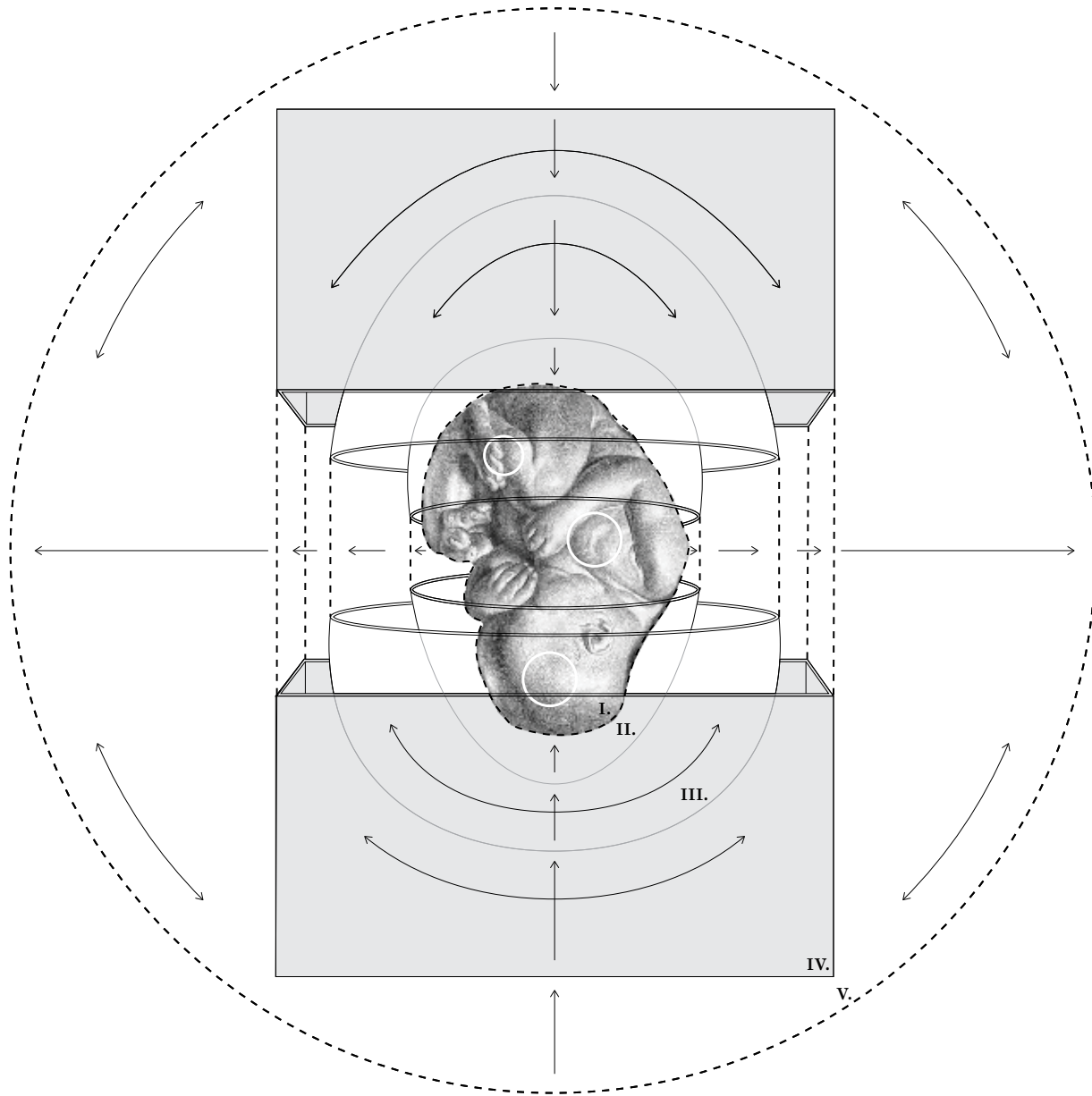


FIGURE [3]

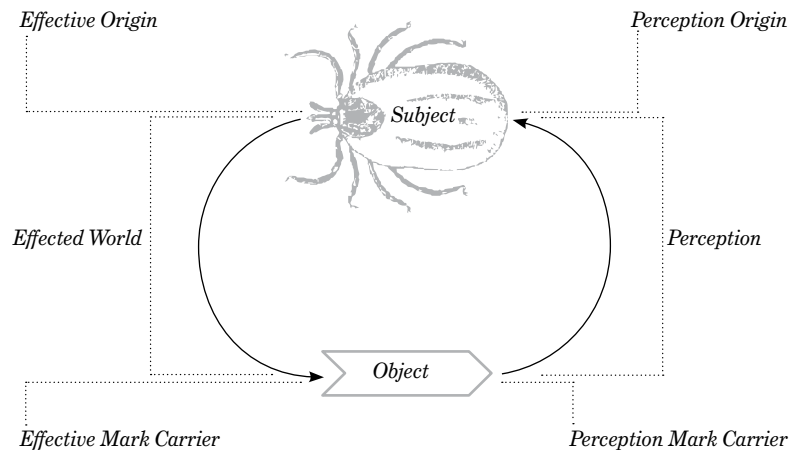
*Parti of research that synthesis the micro within the mother and her exposed architecture. By author.*

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## COMPLEXITIES OF ADAPTATION

FIGURE [4]  
*Subject Perceiving Object, as  
described by Jakob von Uexküll.  
Every individual has their own  
experience with the outside world.*



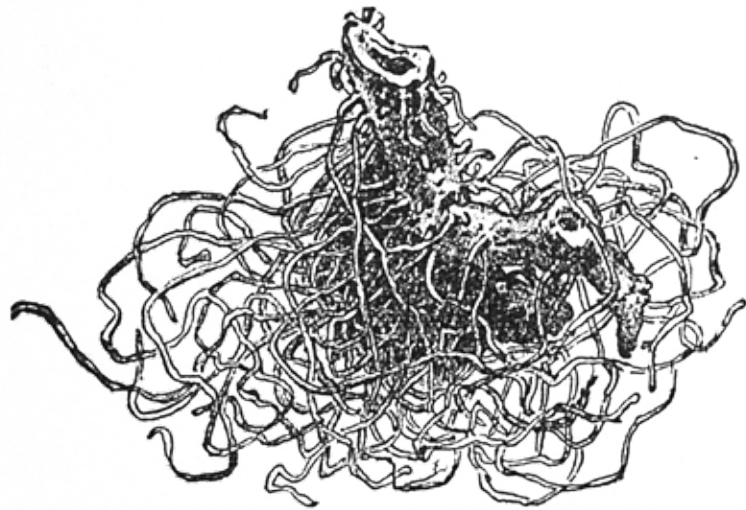
## MULTIPLICITY OF INFLUENCES

Life's complexity is the only way a species can survive. Since the beginning of life itself, the constant interactions of organisms during natural events play a role in the process of natural selection. The famous image of "the evolution of man" shows what we know of our taxonomy connections to our ancestors. However, it is unclear of what major interactions caused this evolutionary path. Human's had to be deemed "fit." The overall fitness of a species is dependent if the species fitness is enough to survive constant negative exposures. These forces may not be constant but a part of a rhythmic timing; that this forces the animal to create an ancestral behaviour that is picked up by the offspring<sup>01</sup>. This process of nature may or may not be favourable for specific species. Nature is always looking at the larger ecosystem and tries to compensate for interactions between subject and object. Our evolution is from these subject and object interactions [4]. The interaction is a measured relationship that is compared to the form and function outcome. Deleuze and Guattari physiological framework brings light to Charles Darwin's work on complex relations in *Origin Species*:

"a multitude [that] has neither subject nor object; only determinations, magnitudes, and dimensions that cannot increase in number without the multiplicity change in nature."<sup>02</sup>

FIGURE [5]

*Dried Rhizome of Caulophyllum thalictroides. The rhizome has no beginning or end and interconnects multiple nodes. Found as Blue Cohosh in the Drugs and Medicines of North America by John Uri Lloyd.*



By analyzing the intensity of a multitude and its relation with other multiplicities, we can synthesize on how humans were derived and what lessons we can learn to improve fitness. This synthesis is Deleuze and Guattari's rhizome [5]. The rhizome creates the non-hierarchical web connecting traits that may not be of the same nature<sup>03</sup>. Synthesizing the rhizome for human evolution will never result in the genetic algorithm for "perfect health." Survival of the fittest is the simultaneous process of perception and reaction. This process is on-going as it would disrupt the constant microbiological progression to adapt.

## ARTIFICIAL EVOLUTION

Scientists can understand genetic modification to enhance certain features, as displayed in combined species of domesticated animals (i.e., dogs). Since knowing that an offspring receives traits from both the biological mother and father, science has furthered this selective customization breeding in hopes to achieve an ideal form. The ideal offspring would then breed to continue their phenotype. Although this process does not consider the potential for uncontrollable variation. Within the internal and external environment, interactions occur that influence a gene's response. Darwin states this as "variation under nature"; the internal environment of a species is its chemical

interactions that output functions that may bring up abnormalities<sup>04</sup>. For the external environment, it is the same as the previously mentioned concept of “survival of the fittest” due to a specific environment and time. Under the restraints of artificial evolution, the external environment is always an influence (even in a petri dish). Bioethical views change when the species under human’s influence are humans themselves. Evo-devo (the science of evolutionary biology<sup>05</sup>) can see the DNA code that exports function/form, and how there are genetic similarities between species. DNA reading has resulted in the commercializing of “designer babies” where parents or a sole influencer describes the features they wish to see in a child<sup>06</sup>. The complete control of an unborn child cannot predict the unseen changes in their internal and external environment. The danger resides with the human archetype removes hierarchal traits that would prepare us for the exposures over a lifetime<sup>07</sup>.

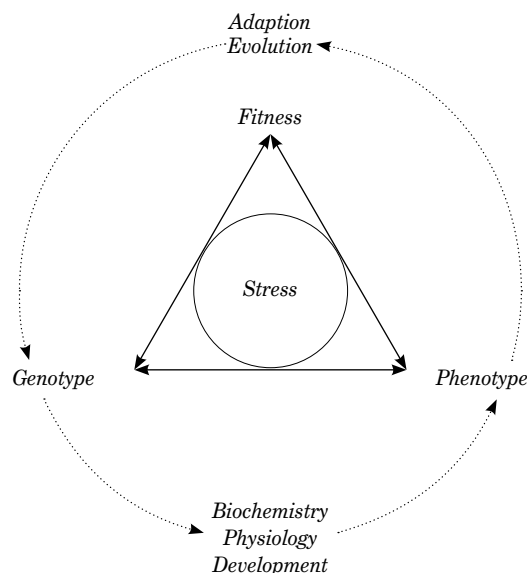


FIGURE [6]  
*Bijlsma's diagram of the long-term  
influence of a species evolution  
within the environment.*



EVOLUTION IN THE  
MODERN WORLD

Life first appeared on this planet approximately 3.6 billion years ago; however, civilization started 6000<sup>08</sup>. Comparing this insignificant amount of time shows that non-manmade environments framed human evolution. However, humans are experiencing the hierarchal passing of disorders caused by a strain that arose from the physical, economic, and mental environments we have created. The stress of the environment affects all organisms. For example, butterflies have been recorded to respond to stress within a generational timeline that resulted in adapting to physical, chemical, and behavioural changes [6]. These environmental stresses were from the weather, food resources, predator populations, migration change, and toxicities<sup>09</sup>. Therefore, that is to say, humans are (if not more) susceptible to this environmental stress; unlike other animals, our mindset is that in order to survive we must overtake nature<sup>10</sup>, resulting in a detachment that goes against our ancestors. *How can we counteract these stresses with the built environment?* It would take many generations to see these interventions and their benefits to well-being. However, attempting to act the multiple influences of the environment is better than not attempting at all<sup>11</sup>.

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## EPIGENETIC REPROGRAMMING

### THE ARCHITECTURE OF THE HUMAN CELL

FIGURE [7]

*Non-specified human cell, these inner parts have their role within the cell membrane and connect to the larger system of the body. Interpreted and illustrated by author.*

The uncountable amount of human cells within the body each contain close to 2 meters of DNA that hold genetic information<sup>01</sup> [7]; this package of information is called a genome. The genome within the cell's nucleus comprises 46 chromosomes organized in 23 pairs. This length of DNA can compartmentalize within the chromosomes by spiraling tight around histone proteins; these act as beads on a string (one "bead" is called a nucleosome<sup>02</sup>). In each nucleosome, there are four major types of histones called H2a, H2b, H3, and H4. The coiled DNA passes over each histone that organizes the DNA's protein complex, allowing it to regulate what genes express to a specific cell it resides within. Every cell (regardless of type) has the same DNA, and the cell will only express what it needed from the gene sequence. An expression is from the histone group that is chemically tagged to turn on/off the correlating gene expression. For example, muscle cells will have tags that turned on the gene sequence that a

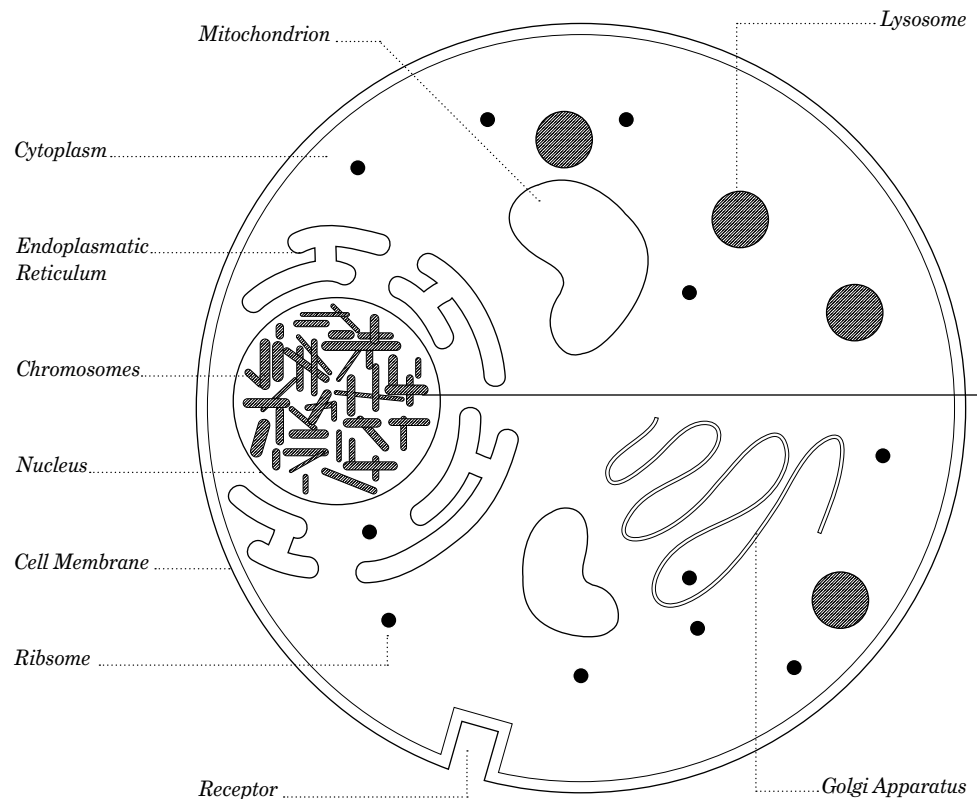
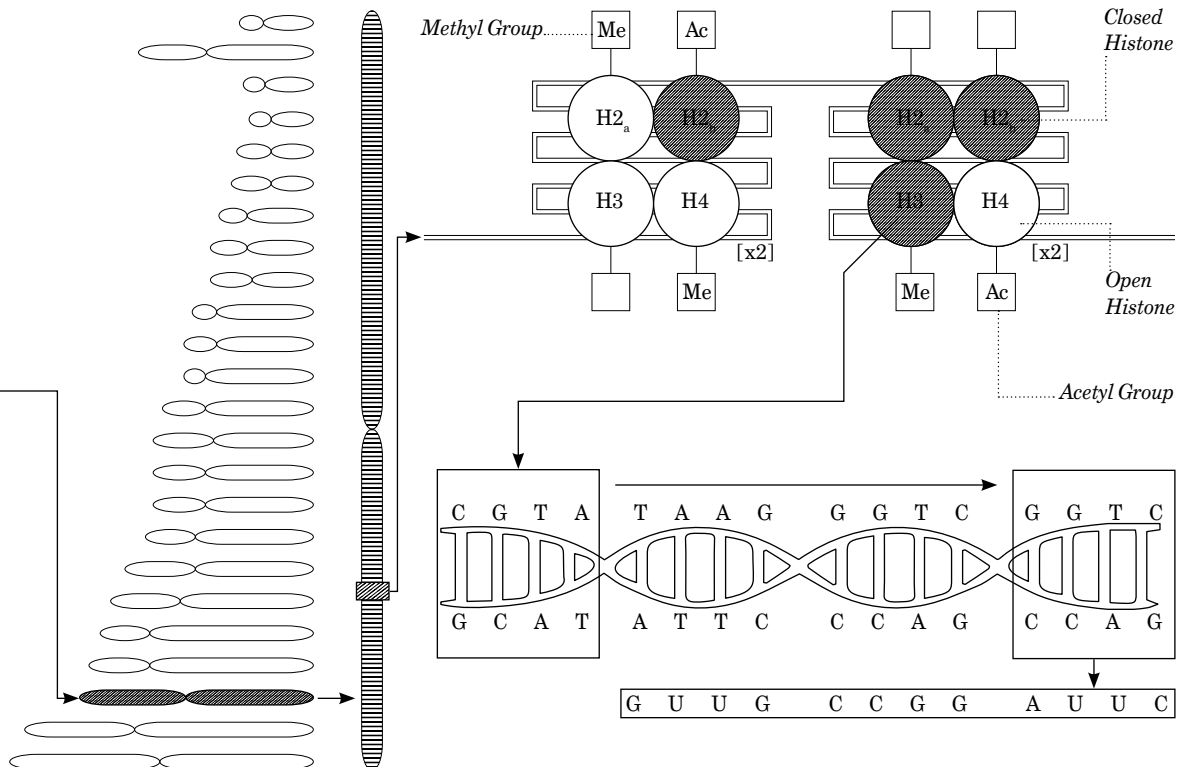


FIGURE [8]

*Reading the DNA within the cell may put out multiple functions that influences the body as a whole. Interpreted and illustrated by author.*

muscle cell requires, but will turn off what a liver cell requires (and vice versa). The understanding of these chemical tags is the root of understanding epigenetics. Epigenetics, meaning above the genome, is the changes in gene function that do not involve a change in the underlying sequence of the gene<sup>03</sup>. When the body sends a signal (i.e., more red blood cells, and secrete for glucose), it will find the receptor within the gene expression, open it, and read the code. The code can be explained in the common understanding of DNA being the double helix. The signal reads one side of the helix and connects with the other side to get an output (the translation of DNA to the RNA code that exports a correlating response). The chemical tags that opened or closed this code are done mostly by acetyl or methyl groups that attach to the histone tail. These tags do not disappear during mitosis (standard cell division) and maintain in the two daughter cells they create [8].



## HEREDITARY EPIGENETIC MODIFICATIONS

Although epigenetic tags are hereditary, there are opportunities for these tags to modify. Modification happens when there is too much or too little of a signal, and it damages the reading. Signals within our body are from the endocrine system, which is responsible for glands to secrete specific types/amounts of hormones<sup>04</sup>. The hormone messengers may cause a cell to output an abnormal function; this will cause a domino effect on the function of an organ or more extensive system (i.e., not enough insulin signals that stops the function of turning glucose into energy results in diabetes). The overexertion of a specific emotion from sensory information has a damaging effect which could be caused by the environment. Any emotion over a long time could be detrimental to the body. Stress, for example, may be caused by the sensory information of unfamiliarity, lack of privacy, variance in proportion, and small spaces could send signals through the endocrine system to release cortisol. Cortisol becomes negative if over accumulated and has been associated with anxiety/depression, obesity, heart disease, asthma, diabetes, headaches, gastrointestinal issues, Alzheimer, accelerated aging, and premature death<sup>05</sup>. These health problems have been known to be hereditary, and therefore affect not just our health but the health of future generations; these health statistics are rising across populations<sup>06</sup> [9]. Understanding the responsibilities of the limbic systems for regulating the emotions associated with sensory information will allow the connection between external and internal environments. However, as mentioned in the previous chapter, the external environment needs to focus on our responsibility to the artificial landscape. Epigenetics is the window to see how architectural exposures affects us at a cellular level<sup>07</sup>. There is hope as we can say that the architectural exposures that may cause hereditary disorders may also be the solution to reverse such effects.

## LINK TO *IN UTERO*

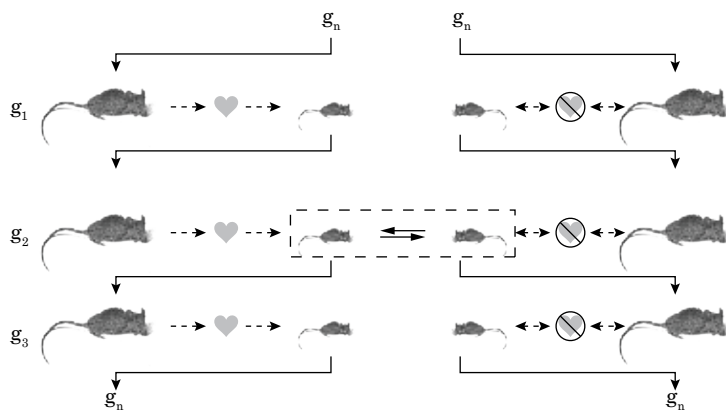
The most crucial time when our genetic reading is most sensitive is *in utero*<sup>08</sup> [10]. During our early development, when the sequence of DNA from biological mother and father is combined, the succession of different cell development relies on the proper hormonal releases within the developing fetus and mother. Previously mentioned, the epigenetic modifications are passed on during mitosis; conversely, during meiosis (sex cell division) they are wiped clean in what is called

an “epigenetic reprogramming”<sup>09</sup>. However, the inherited epigenetic tags caused by the methylation from methyl groups remain with the future child<sup>10</sup>. Not only do they get the inherited tags but the developing body is hypersensitive to exposures within the maternal environment; that may benefit or hinder the well-being of the child. The partnership of the Karolinska Institutet (Stockholm, Sweden), and the University of Toronto Faculty of Medicine have been looking into this research. They have provided evidence that the maternal environment (starting at conception) up to the first 2000 days of life (5 years old) have the susceptibility to pick-up epigenetic modifications, leading in health concerns later in adulthood<sup>11</sup>. Dr. Ola Hermanson, the senior research fellow at the Department of Neuroscience and scientific coordinator of the project at Karolinska Institutet, stated that

FIGURE [9]  
*Epigenetic modifications were proved to be inheritable when Dr. Meaney used lab rat pups who either passed or did not pass maternal behaviour to their young, even if the pup was raised not by its biological mother. Interpreted and illustrated by author.*

“it’s becoming increasingly clear to us how the fetal and infant environments affect how susceptible we are to developing social, mental or physical problems as adults<sup>12</sup>.”

Therefore, we should impose an architecture that promotes a healthy environment for a fetus, which is the mother.





## FIGURE [10]

*The maternal environment is crucial as it takes into consideration the arguments of nature vs. nurture. These twins (drawn by Jan van Rymsdyk) will rely on their subjective well-being from their mother, but each will influence each of their well-being outside of the womb.*



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## THE MATERNAL ENVIRONMENT

### PHYSICAL AND HORMONAL TIMELINE<sup>01</sup>

#### FIRST TERM [0 - 13 WEEKS]

The average pregnancy last 280 days (40 weeks) from the last period. The embryo entirely relies on the mother's endocrine system until the placenta is fully developed; this is when the maternal wellness is extremely important<sup>02</sup>. We divide the pregnancy into three terms, plus postpartum:

[*Proliferation / Day 0-11*] Ovaries mature

[*Ovulation / Day 12-14*] Egg released; conception must happen 12-24 after ovulation.

[*Luteal Phase / Day 14*] Beginning second half of menstrual cycle when the released egg is either fertilized or the next period begins. The corpus luteum secretes estrogen, and progesterone for the lining of the uterus to thicken. Progesterone raises uterus temperature.

[*Conception / Day 12-15*] Corpus luteum continues to secrete estrogen and progesterone due to the help of hCG.

[*Implantation / Day 24*] The divided cells (blastocyst) attaches to uterus walls. Connects to mother's blood stream. Will produce red blood cells till week 6.

[*Week 4*] Cells are multi-structural, axis for the body created; arm and leg buds appear; heart and nasal cells develop; relaxin, prolactin and hPL starts to rise with growing placenta; cortisol levels rise in throughout pregnancy for need of a heavier blood flow

[*Week 5*] Brain development, head enlargement, early kidney development; progesterone levels must be adequate at this point in order to continue pregnancy

[*Week 6*] Joints of upper limbs, eyes, head large with neck

[*Week 7*] Sense of touch and proprioception develops

[*Week 8*] Limb movement, ossification in lower limbs, head very large (half of size of embryo), resembles human, startle reflex, genital form but not distinct, nose form; equilibrioception sense develops.

[*Week 9-12*] Growth in body and limbs, ossification skeleton and skull, intensities are internal (body totally enclosed), red blood cells decrease in liver and begin in spleen, urine formation, ability to swallow; week 9 placenta secretes its own estrogen (estriol) to increase oxytocin receptors on uterus wall; week 10 progesterone rises more gradual



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**SECOND TERM**  
[14 - 26 WEEKS]

[Week 13-16] Growth, movement, ossification, genitals recognizable, eyes and ears closer to position; taste develops at week 13; week 13 hCG is at its peak to maintain the pregnancy; week 14 relaxin steadies off; week 14 cortisol rises for cardiac support and decreasing glucose levels

[Week 17-20] Growth slows down; limbs reach mature position brown fat deposited; week 20 oxytocin starts to rise

[Week 21-25] Fetus gains weight, rapid eye movement, surfactant secretion begins but respiratory immature, fingernails, may survive if premature

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**THIRD TERM**  
[27 - 40 WEEKS]

[Week 26-29] Lung developing, eyes open, toenails visible, fat 3.5%, production of red blood cells moves to bone marrow; smell and hearing develops at week 26; week 27 relaxin rises again; cortisol continues to rise for lung development

[Week 30-34] Pupillary light reflex, pink and smooth skin, limbs chubby, 8% fat, 32 week able to survive; vision develops at week 30, but not completely developed till birth when due to photoreceptors.

[Week 34] Estriol rises more gradual

[Week 35-38] Firm grasp orientates towards light, 18% fat

[Week 40 / Labour] Full term; progesterone and prolactin drops slightly; cortisol will rise variable to stress of the environment; oxytocin spikes in a positive feedback loop; first stage starts non-intense contractions; second stage of 10 cm dilated

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**POST PARTUM**  
[6 WEEKS POST]

[Week 2 Post] Prolactin has risen since slight drop during labour to help with milk production; oxytocin rises during lactation.

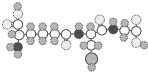


[Week 6 Post] Hormonal levels should be return back to normal; relaxin levels may be maintain in some cases 5 months' post; prolactin only starts to drop; uterus returns to normal size.

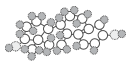
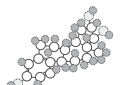
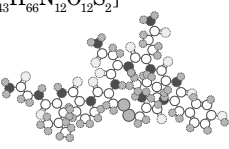

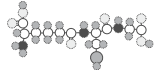
ENDOCRINE SYSTEM<sup>03</sup>

## FIGURE [11]

*Each hormone listed is paired with an illustrated graphic of its molecular structure. Interpreted and illustrated by the author.*

The endocrine system is crucial in supporting the function of the mother for fetal development, parturition, and supporting a newborn [11] [12]. There are endocrine milestones during the pregnancy, and any disturbance of the response of the internal via external will jeopardize these relationships<sup>04</sup>. The hormones are essential for overall well-being; there are several that play crucial roles during the ideal nine months [13]:

[Role]	Kick starts growth of placenta; maintains release of estrogens and progesterone; promotes crucial cell growth in first trimester; nervous tissue development; starts fetal glands to promote its own cortisol	<b>HUMAN CHORIONIC GONADOTROPIN/hCG PROTEIN</b> [C <sub>11</sub> H <sub>19</sub> N <sub>3</sub> O <sub>6</sub> S]
[Emotions]	Hunger, nausea/vomiting, lower energy levels, sensitivity to glucose	
[Epigenetic Modifications]	Methylation of luteinizing hormone; may cause infertility of male fetus	
[Role]	Long-term stress hormone ; relationship to the timing of labour; regulates blood pressure; balances estrogen and progesterone; helps fetus' lung development	<b>CORTISOL STEROID</b> [C <sub>21</sub> H <sub>30</sub> O <sub>5</sub> ]
[Emotions]	Vigilance, stress, sadness	
[Epigenetic Modifications]	Methylation of corticosterone hormone; Cushing's Syndrome; obesity; high blood pressure; depression; anxiety	
[Role]	Maintains the pregnancy; Smooths the muscles of the uterus, and other organs (i.e. vascular system; Balances cortisol's effects	<b>PROGESTERONE STEROID</b> [C <sub>21</sub> H <sub>30</sub> O <sub>2</sub> ]
[Emotions]	Fights stress, sensitive to metabolic system, sensitive to carbon dioxide, increases body temperature	
[Epigenetic Modifications]	Methylation of P(G)R-(B) gene; connections in endometriosis, mammary gland malfunction, delay of puberty	

[Role]	Helps blood circulation of uterus	$\overline{\text{ESTRADIOL}} / \text{E2}$ $\text{STERIOD} [\text{C}_{18}\text{H}_{24}\text{O}_2]$
[Emotions]	Respiratory rates; vigilant	
[Epigenetic Modifications]	Methylation of ERa and ERb gene; hemorrhagic follicular cells; bone development; nerve development	
[Role]	Only secreted by placenta for reproduction; levels related to the well-being of the fetus (low being stressed); creates receptors for oxytocin on the uterus wall; makes pathway for pain-killing during labour	$\overline{\text{ESTRIOL}} / \text{E3}$ $\text{STERIOD} [\text{C}_{18}\text{H}_{24}\text{O}_3]$
[Emotions]	Respiratory rates; vigilant	
[Epigenetic Modifications]	Methylation of GPER gene; liver disease; high blood sugar; unbalanced bone density	
[Role]	Muscle contractions during birthing process; Mammary gland milk ejection	$\overline{\text{OXYTOCIN}}$ $\text{NEUROPEPTIDE}$ $[\text{C}_{43}\text{H}_{66}\text{N}_{12}\text{O}_{12}\text{S}_2]$
[Emotions]	Love; trust; compassion	
[Epigenetic Modifications]	Methylation of OXTR gene; connections in autism diagnosis	
[Role]	Facilitate metabolic state to give energy to fetus; Grows fetus and placenta; Assists with mammary glands	$\overline{\text{HUMAN PLACENTAL LACTOGEN}} / \text{hPL}$ $\text{PROTEIN} [\text{C}_8\text{H}_{17}\text{NO}]$
[Emotions]	Safe, respiratory rates	
[Epigenetic Modifications]	Methylation of GHR gene; growth deformities	
[Role]	Mammary gland milk ejection; Balances estrogens and progesterone	$\overline{\text{PROLACTIN}}$ $\text{STERIOD} [\text{C}_{11}\text{H}_{19}\text{N}_3\text{O}_6\text{S}]$
[Emotions]	Irritability, anger	
[Epigenetic Modifications]	Methylation of OPC cells; lack of development in brain neuro- system; epileptic seizures	

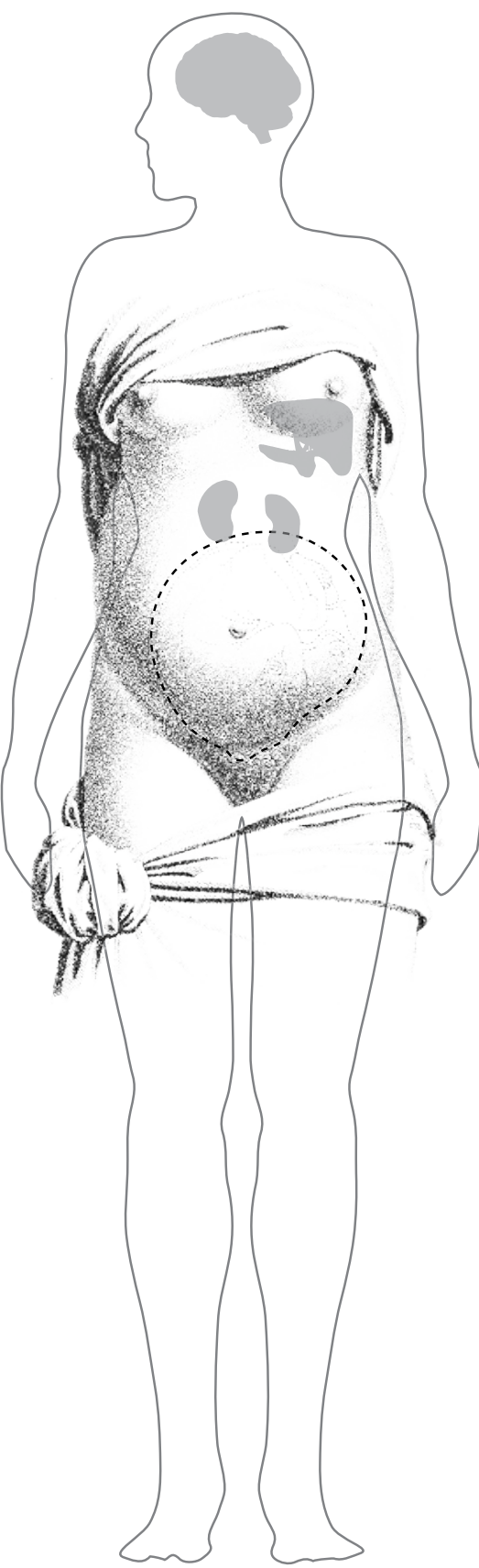


FIGURE [12]  
The female body changes internally and externally. The organs secreting the hormones are interlinked to the brain that connects into an emotional relevance.

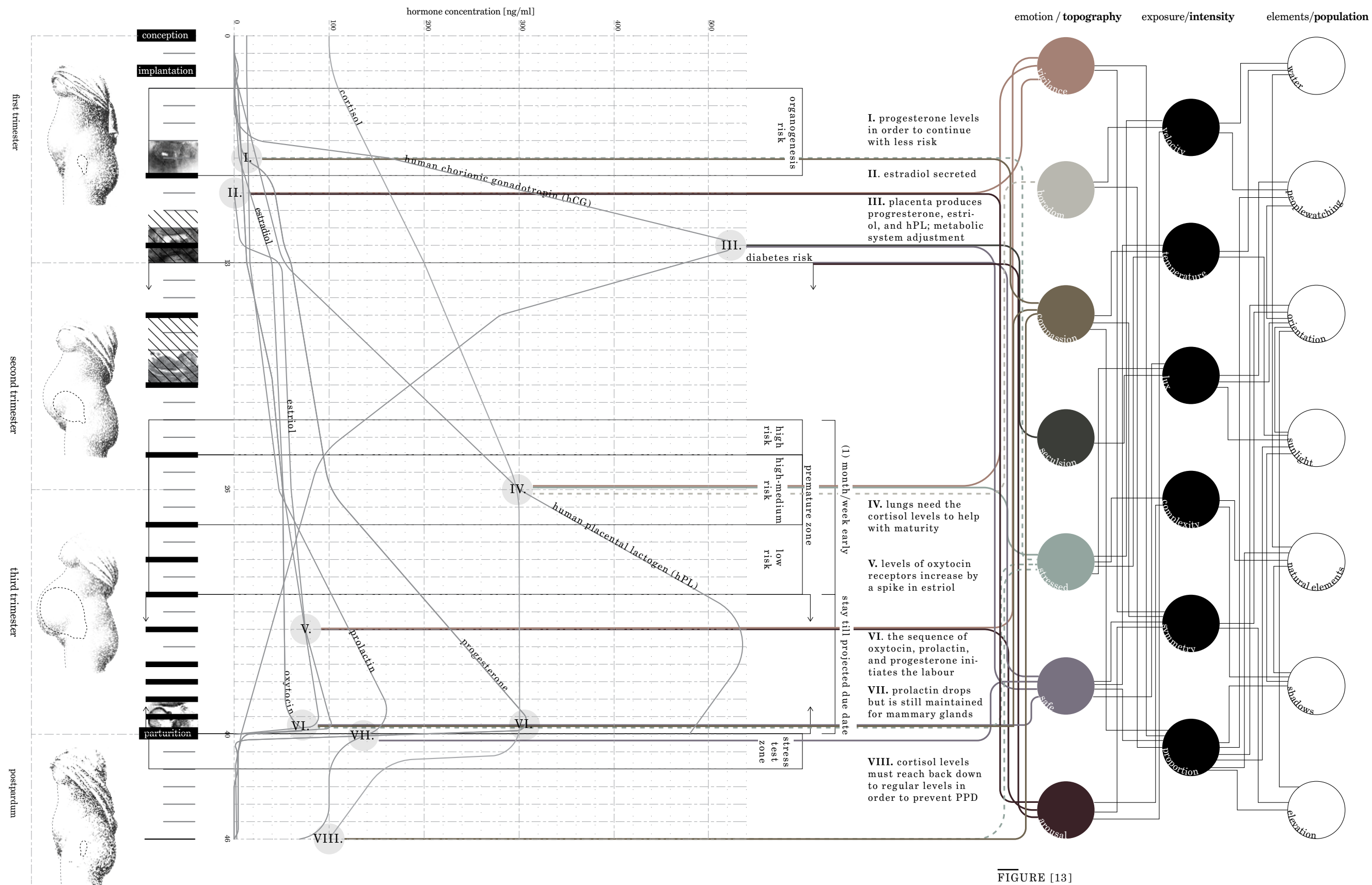


FIGURE [13]  
The graph was an early development of the hormone concentration, check-ups, and architectural relations to emotions. By author.

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## THE LIMBIC SYSTEM

### HOW OUR BODY READS THE BUILT ENVIRONMENT?

All human senses, some more than others, interact with the outside world. When trying to understand an architectural feature, we will use more than one sense at a time to gather information in order to understand its existence (phenomenology)<sup>01</sup>. A sense(s) engage(s) a cellular response that will reach the neurotransmitters in the brain, to signal a gland to secrete a specific hormone. The hormone can either go directly to the blood, another hormone, or nervous system; all in order to reach a target cell. A single hormone may interact with multiple cells as the hormone is the key that may have its lock on different cells. Therefore, a single sense may trigger the reaction of multiple cellular functions. When we create sensory patterns due to the external stimuli, the primary emotional states are expressed<sup>02</sup>. For example, the response of a threat will be either the fight or flight response. Our survival always relied on the response of a certain sense, and the ability to continue this in a building concept that expresses the appropriate sensory information would have a multigenerational benefit to well-being<sup>03</sup>. The sensory information that are applicable to architectural spaces are:

#### SIGHT

Gives us information for an environment's: light, spatial, proportional, colour, movement, pattern, material, familiar, and system qualities. When it comes to visualizing there is a tendency to understand better with that of a different element (i.e., light vs. dark, heavy vs. light material)<sup>04</sup>. Vision has a range and direction that have different perception qualities. Direct focus gives awareness to a single object while a broad background links to reading emotions. For example, neurophysiologist Margaret Livingston described looking directly at Leonardo da Vinci's painting of the Mona Lisa brings attention to the proportion of facial features. However, by looking at other points in the background of the painting her smile becomes more prominent<sup>05</sup>.

#### SMELL

Gives information for an environment's: materiality, and familiar qualities. With smell, we can access our long-term memory of a specific place, relationship, and experience<sup>06</sup>.

#### SOUND

Gives information for an environment's: spatial, movement, pattern, material, and familiar qualities. Sound is critical for the recognition links to endocrine responses<sup>07</sup>.

*TOUCH*

Gives information for an environment's: spatial, movement, pattern, material, familiar, thermal, and system qualities. Texture connects the feeling of comfort and discomfort; the sense of touch is critical for the appropriate emotional response to materiality<sup>08</sup>. During pregnancy, the fluctuations of estrogen and progesterone make it more difficult for the female body to regulate heat<sup>09</sup>.

*PROPRIOCEPTION*

Gives us information for an environment's: spatial, proportional, movement, and familiar qualities. Proprioception is an internal sense but still responds to the comprehension of our body's reading of a space<sup>10</sup>.

*EQUILBRICEPTION*

Gives us information for an environment's: spatial, proportional, and movement qualities. Being the sense of balance, it can put humans in an equilibrium state<sup>11</sup>.

*RESPIRATION*

Gives us information for an environment's: spatial, colour, movement, thermal, and familiar qualities. Respiration is the receptor detecting a need for more oxygen in the bloodstream<sup>12</sup>. Respiration usual comes from activity, however comprehending certain qualities may trigger someone to be uneasy and stressed.

*CHRONOCEPTION*

Gives us information for an environment's: light, colour, movement, material, patterns familiar, thermal, and system qualities. Chronoception is the subjective experience of time<sup>13</sup>. Understanding the concept of time may be shown in aging, rhythmic patterns, and etc.<sup>14</sup>.

SYNTHESIZING FOR  
EMOTIONAL RESPONSE

Gathered sensory information brings emotional reactions that we can synthesize. Emotion, being at the core of human nature, is how a sense's intensity could be measurable<sup>15</sup> [14]. As we tend to understand things with either a positive or negative, emotion should not be deemed as good or bad as each emotion is part of an internal purpose. Emotions only become harmful if it becomes a long-term experience. For example, stress has beneficial factors as it promotes patterns of behaviour to improve an organism's fitness<sup>16</sup>; if prolonged stress may result in depression and anxiety. As there is a multitude

of words describing emotions, there are groupings of words that are critical during pregnancy. These include:

***BORED***  
[*TIRED* /  
*DETACHED*]

Caused by qualities that may cause boredom is tedious repetition and a lack of information. Preventing boredom by repetition if a part of a pattern found in nature (golden ratio) could give further depth and ease boredom<sup>17</sup>. Can also be done by contrasting elements (i.e., light and dark)<sup>18</sup>.

***AROUSED***  
[*INTERESTED* /  
*MOTIVATED* /  
*DISTRACTED*]

Caused by peaks of relatability and creativity. Arousal is linked to the dropping vigilance as it preoccupies a task performance<sup>19</sup>. Arousal could link imagination and dreaming that could be caused by whimsical curvatures found in nature<sup>20</sup>.

***STRESSED***  
[*FEARFUL* /  
*ALARMED* /  
*ANXIOUS* /  
*CHAOTIC*]

Caused by symbolism that triggers endangerment, and the not being able to comprehend or control an object or situation. We find chaos in intricate patterns that have a sensory overload. A focal point can stop the eye from wandering and allow a visual direction to understand a pattern/space<sup>21</sup>. Hierarchy forms also allow a complicated pattern to find calmness as it promotes self-confidence in a controlled system<sup>22</sup>. Stress will always reside in specific rooted fears (i.e., elevated and overlooking moving water)<sup>23</sup>.

***SAFE***  
[*SECURE* /  
*RELAXED* /  
*TRUSTING*]

Caused by the lack of symbols that trigger endangerment, non-sporadic reading of senses, and pleasant familiarity. Ancestral females main focus was to stay safe by understanding their mobility, time, and energy<sup>24</sup>. Safety compels us to move forward when appropriate (once we understand the spatial qualities)<sup>25</sup>. When we want to stay still, we need to know there are no threats at all points. By being confined and seeing the entire space, we can achieve this security (without crossing the threshold of being claustrophobic)<sup>26</sup>. The ability to become relaxed puts the human body in energy saving mode as we instead save energy for when it is needed (i.e., when we are stressed)<sup>27</sup>.

***VIGILANT***  
[*ATTENTIVE* /  
*CONSCIENTIOUS*]

Caused by the need to focus, or when we are goal oriented. We become vigilant when we need something, and this can translate to stress if prolonged or we do not achieve the desired outcome. Ancestral we were vigilant for resources like food, water, and shelter. As we are no



longer hunting and gathering in modern cities, we still require the need to understand our surroundings. Wall hugging (or a foliage line or river) is one way we spatial learn and creates a mental map<sup>28</sup>. To comprehend our social environment, we need to be close enough to hear people, but not necessarily close enough to have a conversation (approx. 7 meters)<sup>29</sup>. To enhance our vigilance one would need to be unstimulated (bored) prior, as vigilance cannot last for long periods until we become stressed<sup>30</sup>.

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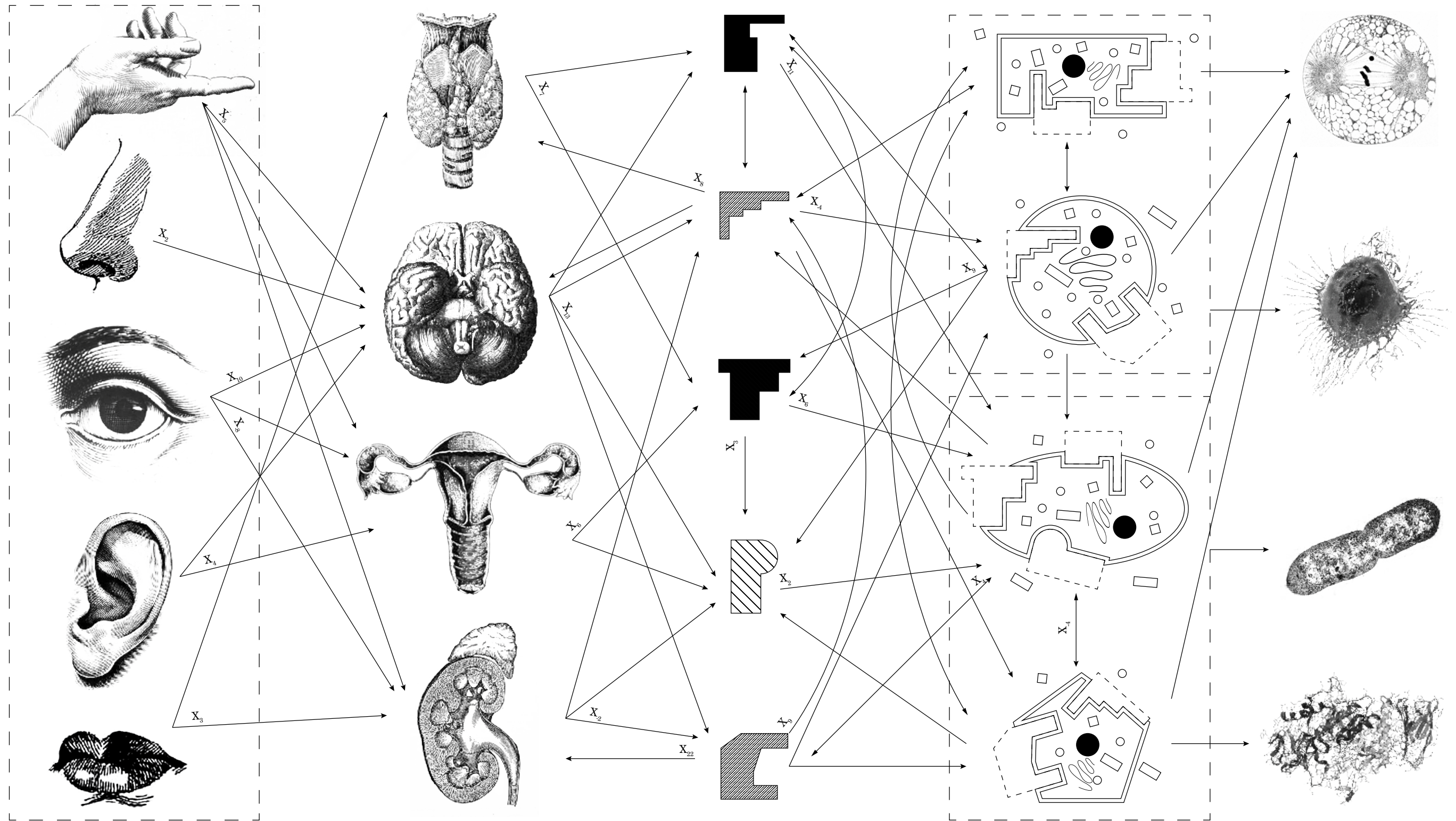


FIGURE [14]  
This diagram shows the interconnection of the senses and emotional response. The senses connect to the glands to secrete the proper hormonal change. This chain reaction may result in many transformations and makes it a metamorphic process. Interpreted and illustrated by author.



# PART II



## OBSTETRIC CARE

### MEDICALIZING PARTURITION

Parturition, giving birth, is the final significant act of a pregnancy. Although the duration of a fetus in utero has a more prolonged exposure than that of the labour, it is essential to see the historical traumas expecting mothers went through. This lack of consideration provides justification for a future program to promote the well-being and self-empowerment of women. In early civilization, births were celebrated and a part of a sacredness that reflected in the architecture and art<sup>01</sup> [15]. The birthing process was considered a woman's power and seen as a motif within ancient religion. Preceding into early Greek and Roman life, men had a curiosity with the technicalities of birth. The first OB was Soranus, who started drawing and understanding the process but it was still considered a woman's domain<sup>02</sup> [16].

At the turn of the medieval era and the spread of Christianity, the Bible's word was taken that in the first testament women needed to experience the pain of childbirth as it was Eve's consequence from the Original Sin [17]. The midwives who helped women during this time were considered witches as they were going against the church<sup>03</sup>. Midwives at the witch-hunt were interrelated as many were executed during this hysteria (i.e., Agnes Sampson, Scotland, 1591) [18]. The hidden practice of midwives broke the passing of education and intuition, resulting in unsterile birthing practices and would carry diseases affecting mother and child<sup>04</sup> [19].

At this point, birthing looked at as an illness that needed man's intervention<sup>05</sup>. Men intention was not only to help the unaided woman but were an outlook to create and tools to make them seem superior (e.g., Chamberlain forceps)<sup>06</sup> [20]. Men's involvement was seen in both Europe and North America. In the 19th century, hospitals in Europe were set up as urban charity asylums to serve the poor, sick, and homeless; underprivileged women were forced to be a part of this institution that was run solely by men<sup>07</sup>. Due to morals of a men's exposure to female genitals, the experimentation on poor women would be seen as training for the more "lady-like" rich women who gave birth in the luxury of their home<sup>08</sup>. In the United States, slavery gave the godfather of gynecology, Dr. J. Sims, the opportunity performed experiments on African slaves and tried to create physical interventions for birth control<sup>09</sup> [21]. Women lost all control in assisting other women during parturition; in 1848, the



[15]



[17]



[19]

500 BC ||| 100 ||| 1500 ||| 1600 ||| 1700 |||



[16]



[18]

FIGURE [15]

*Phoenician Goddess with Pregnant Stomach and Birthing Stool. Found at the Israel Museum, Jerusalem*

FIGURE [16]

*Diagrams of Uterus showing fetal positions. A series of medical treatises translated from the Greek into Latin is included in the Bibliothèque Royale under the signature MSS 3701-15.*

FIGURE [17]

*Midwife Delivery woodcut. 16th Century. From the University of San Diego*

FIGURE [18]

*Agnes Sampson Trail in 1591.*

FIGURE [19]

*A medical engraving from The Court Midwife by Justine Siegemund, illustrates a breech birth, 1690.*





[22]



[26]



[21]



[24]

1750

1850

1900

1950

2000



[20]



[23]



[25]

FIGURE [20]

*Drawing of Childbirth with use of Forceps, by William Smellie, 1754.*

FIGURE [21]

*James Marion Sims, M.D. preparing to examine a slave girl. Found in The History of Medicine, 1952.*

FIGURE [22]

*Female experiencing "female hysteria". Found in Delahaye and Lecrosnier's Etudes Cliniques sur l'Hystero-Epilepsie, ou Grande Hysterie, 1881.*

FIGURE [23]

*Mrs. Gilmer and her baby. Death caused by childbed fever. Photographer unknown.*

FIGURE [24]

*Maternity ward of the late 19th or early 20th century. Photographer unknown.*

FIGURE [25]

*Nursery in Oregon, 1965. Photographer unknown.*

FIGURE [26]

*Ballarat Health Services' Birthing Suite, 2018. Photographer unknown.*

American Medical Association established licenses that excluded midwives and promote hospital deliveries<sup>10</sup>.

While midwives were no longer to promote their services for home births, doctors did not wish to travel to individual homes as it was more convenient for women to go to the hospital<sup>11</sup>. Women coming to the maternity ward at hospitals did not help the event of childbirth [23]. Hospitals had extreme mortality rates from childbed fever<sup>12</sup>, as well as hysteria in pregnant women who were fearful over childbirth [22]. Cases involved women fleeing, escaping, and committing suicide than being administrated to a hospital<sup>13</sup>. By 1930, births resulting in death/injury raised from 40 to 50 percent; all while 60 to 75 percent of births were done at the hospital<sup>14</sup>. The architecture of shared space in the hospital was trying to reflect the aesthetics of the home<sup>15</sup>, but the sensory description of the labor to delivery and then later to recovery only heightened the mother's fear. Vivid stories within Arms text, *Immaculate Deception*, described a loud, chaotic atmosphere, visual separation from the support system, bright lights, drastic change in temperature, multiple room changes, and the disconnection of the newborn<sup>16</sup> [24] [25]. An experience like this was common for women even with a more privileged background. Hospitals like the Royal Victoria Hospital in Montreal had separate entrances for each class; rich women entered from the street, poor women entered from underground<sup>17</sup>. By 1970s women wanted a say in their delivery environment, and in 1980s the birthing suite was introduced where a natural birth could be experienced; freestanding birthing centres were initiated across North America<sup>18</sup>.

Today, most women have the option of either giving birth in a hospital, birthing centre, or at home [26]. Unfortunately, during stages of development if the pregnancy is classed as high-risk, then they will have to go to an OB, regardless of the birth plan. The experience of birth is subjective with either having the opportunity of being a relaxed or a stressful one. Architecture that provides for the care of pregnant women has only recently started giving women the say again over their experience. The medical field of obstetrics does serve a purpose as it helps the high-risk cases, however, bridging the gap of services during parturition as well as prenatal health would be a step

## ARCHITECTURE AND PROGRAM OF OBSTETRICS

### *THE HOME*

forward in this complex development of life.

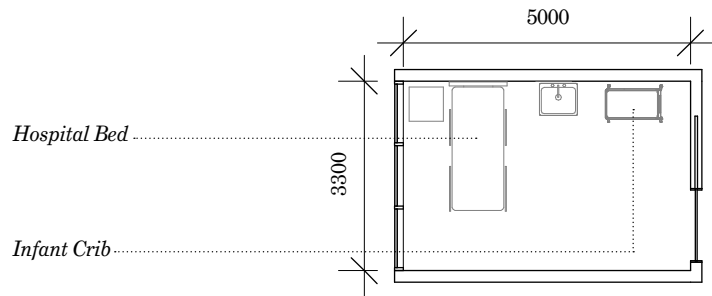
There are several spaces that an expecting mother may perceive during her pregnancy. Those worth investigating include:

A woman may spend a decent portion of her time at home. The home becomes an umbrella of subprograms (i.e., bedroom, living room, dining room, kitchen, and bathroom) and provides comfort due to the familiarity of surroundings. Unfortunately, some expecting mothers may find themselves in a situation of being in a broken home with social and financial burdens. Some women may not have a permanent home and are forced to rely on unhealthy relationships (creating the seriousness of a need to escape). Home offers a place for her to be social with family and a community. For parturition, home is recommended in low-risk cases as long as supported with a midwife or obstetrician<sup>19</sup>.

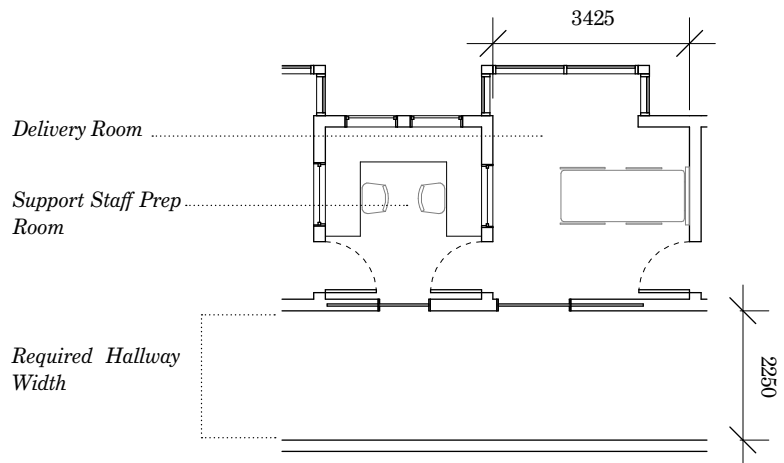
### *MATERNITY WARD*

Canadian maternity wards in are mostly used for the program of a partition [27] [28] (whether vaginal or caesarean), but can also offer prenatal clinics. Prenatal clinics start at approximately the 28th week for those who wish to give birth in the obstetric unit. The clinic includes health assessments, care plan, and psychosocial assessments<sup>20</sup>. Prenatal also offers mental preparation for labour & birth, caring for newborn, breastfeeding, emergency medical response for newborns, diabetes education, and more or less depending on the hospital. During the birthing process, uncomplicated births can discharge within 24 hours, with difficult births at 48-72 hours. Premature births have an exponential time frame where before the 32 weeks a newborn should be at the hospital for a month for every week prior; this continues up until the blurred line of 23 weeks, where the survival rate is questionable. A woman's experience at the hospital is subjective to what room she occupies. Those who are high-class and/or receive benefits will have a separate recovery room and attentive experience; those who are low-class and/or receive no benefits will share a room with another family and may receive minimum consideration by the hectic staff. Hospitals finishes try to be modern with updated architectural features (i.e., window glazing percentage, materiality, furniture, access to green spaces); aspects

[SINGLE RECOVERY ROOM  
WITH CRIB]



[LABOUR ROOM WITH SUPPORT  
STAFF AREA]



[SHARED LABOUR ROOM WITH  
WASHROOM]

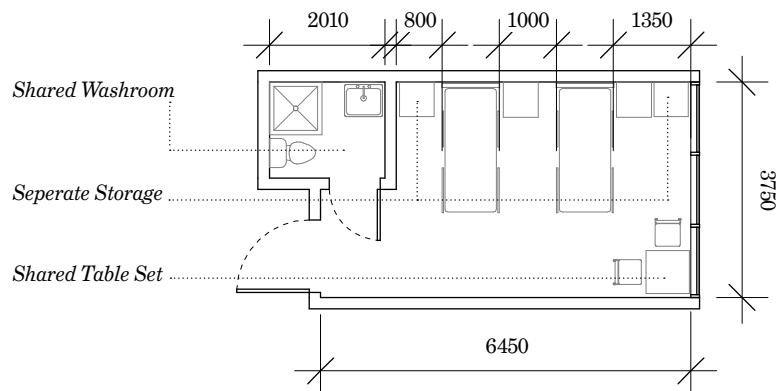
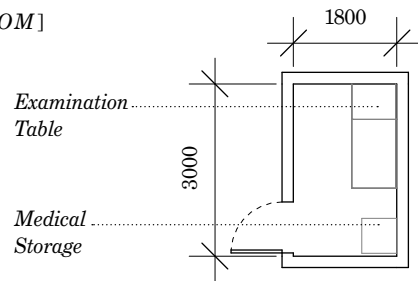


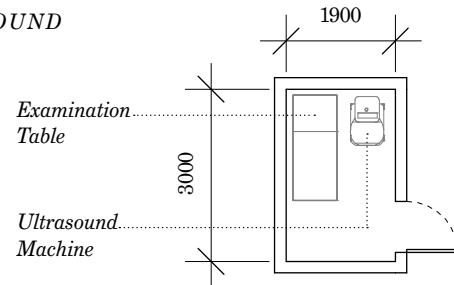
FIGURE [27]

Multiple rooms found within the maternity ward with minimum size requirements. Found in Neufert's Architects' Data and interpreted by author.

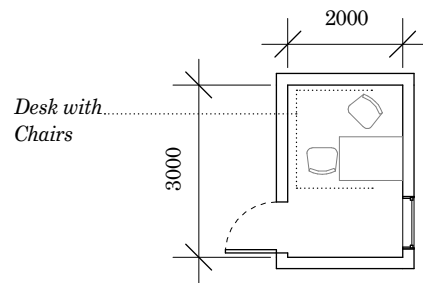
[EXAM ROOM]



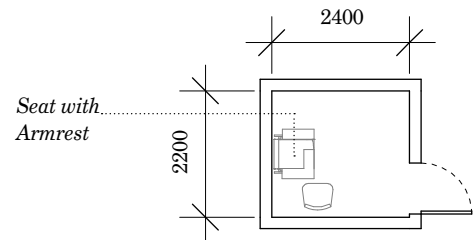
[ULTRASOUND ROOM]



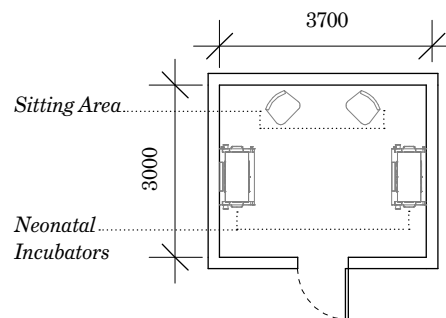
[CONSULTATION ROOM]



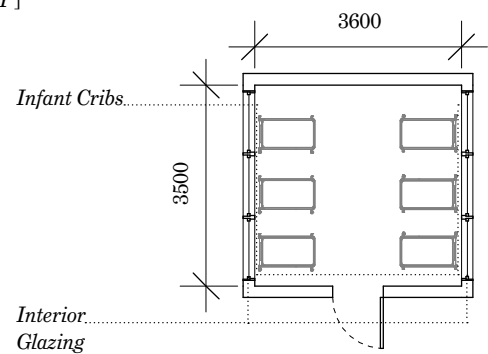
[BLOODSAMPLE ROOM]



[NEONATAL NURSERY]



[NURSERY]



of the maternity hospital still trying to resonate with the feeling of home<sup>21</sup>. Unfortunately, the feeling of home is usually only obtained by the few<sup>22</sup>.

### *FAMILY CLINIC*

The family clinic (with usually the family practitioner) is the place for term check-ups for those mothers who are not going through midwifery. These prenatal appointments are crucial for knowing the health of the baby through ultrasounds and other maternal examinations (i.e., blood/urine tests). Here a doctor will diagnose a low or high-risk pregnancy and any precautions that are needed before parturition. The family clinic may offer familiarity depending on the relationship with the doctor, clinic, and previous experiences. The family clinic is a stepping stone to that of the maternity ward and is a part of an impersonal administration process. The administration includes the check-in desk, waiting room, and exam room. The environment as mentioned early may be familiar, however, lacks a variety of stimulation to the external stimuli and may cause stress due to overcrowding, an intensity of noise, and lack of natural daylight.

### *BIRTHING CENTRE*

At the birthing centre, women work directly with a midwife who will be a part of their entire pregnancy [29]. The midwife answers any concerns the woman may have, as well look over the ultrasounds/ tests (done outside of the centre). The birthing centres offer prenatal examination, education classes, family health and nutrition, physical fitness, parenting workshops, and clothing shop<sup>23</sup>. Mothers and their support system are welcome to roam freely around the centre<sup>24</sup>. During the event of a low-risk labour midwives try to empower a woman's own ability for childbirth (with the assistance of a small team). During parturitions, options are opened to include a large birthing tub/shower, birthing balls/stools/slides, and large non-medical beds. Women may leave up to 8-12 hours after birth with post-partum checkups required<sup>25</sup>. The goal is to have a safe, effective, and little pain as possible during labour. If at any point the pregnancy/ labour is deemed high-risk, the mother will need to see an OB at a hospital and continue her experience there<sup>26</sup>. Due to the history of the birthing centres only starting up in the 1980s, there has not been an original prototype; the centre has taken the program of the hospital, school, and home into two spatial realms of prenatal and

birthing<sup>27</sup>. The birthing centre is seen in competition to that of the hospital program<sup>28</sup>.

### *ULTRASOUND CLINIC*

The ultrasound clinic is separate from that of the family doctor/birthing centre, and may not even be in the same building as that of other obstetrical services. The different services will involve the time to get to know an entirely different staff/environment. There is a minimum of 3 ultrasounds required during pregnancy (more if at a higher risk or if surpassed due date).

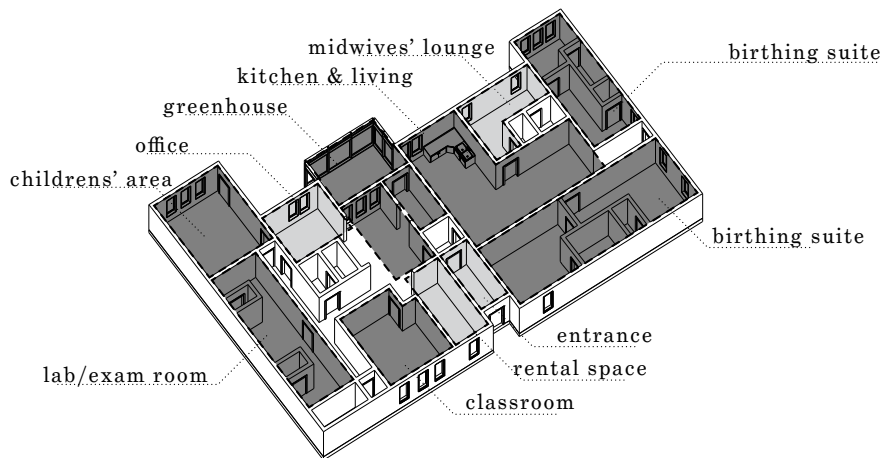
### *THIRD PARTY CLASSES*

Other classes may be available in one's community that involves breathing techniques for birth (Lamaze, Bradley method, Alexander Technique, and Hypnobirthing). Other classes may be similar to that available at a hospital. Schools, gyms, and rental space could host these classes.

FIGURE [29]

*Axo of typical birthing centre. Found in Weisman's, Discrimination by Design: A Feminist Critique of the Man-Made Environment, 1992. Interpreted and illustrated by author.*

[BIRTHING CENTRE AXO]



[MATERNITY WARD AXO]

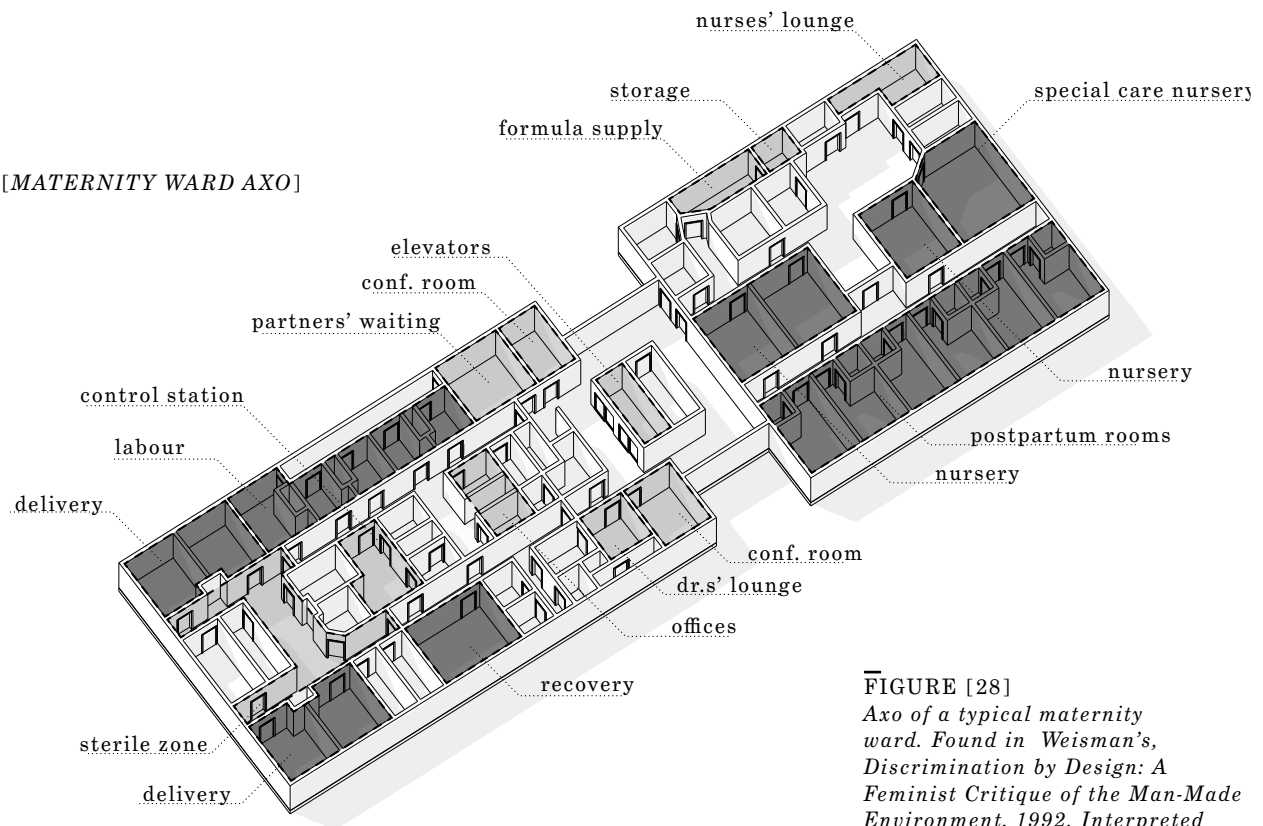


FIGURE [28]

*Axo of a typical maternity ward. Found in Weisman's, Discrimination by Design: A Feminist Critique of the Man-Made Environment, 1992. Interpreted and illustrated by author.*



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- 07 Weisman, L., "Public Architecture and Social Status", in *Discrimination by Design: A Feminist Critique of the Man-Made Environment*, 35-66, Urbana: University of Illinois Press, 1992, 49.
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## ARCHITECTURE FOR WELL-BEING

The encouragement of a user's well-being within architecture begins with the grounding of the spirit-of-place. The spirit-of-place connects the conjunction of sensory, emotional, and behavioural satisfaction<sup>01</sup>. What architectural features work towards this trifecta? Architectural theory on cognitive and biophilic design have listed several architectural elements considers designing for well-being. Kellert defines biophilic design as "the increasing recognition that the human mind and body evolved in a limbic rich world, one that continues to be critical to people's health, productivity, emotional, intellectual, and even spiritual well-being<sup>02</sup>." That is to say by incorporating biophilic design we benefit our species evolutionary fitness. Case studies, such as *The Maggie Centre* (Manchester, UK), by Foster + Partners, were seen as an example of using a biophilic [31] and behavioural understanding of social spaces [30]. This architecture promoted a positive lifestyle during cancer treatments; as the same lessons can be brought to a program for development. These architectural elements and their qualitative readings are:

### WATER

Has potential qualities of quality, quantity, clarity, and movement<sup>03</sup>.

### VENTILATION

Has potential qualities of movement, disgust, stimulations, touch, smell, visual appeal<sup>04</sup>.

### SUNLIGHT

Has potential qualities of lux, temperature, time, and movement. Sunlight promotes productivity, and the feeling of safety as it can expose the dangers ahead<sup>05</sup>. Sunlight can be excessive when there is no mitigation of glare. Sunlight can play the role of a clock since we naturally associate the timing of the day with the position of the sun<sup>06</sup>. When applying sunlight in a design initiative, multi-directional lighting is best for a full grasp of space<sup>07</sup>. For linear programming, the heat from the sun could offer thermal qualities and basking opportunities.

### VEGETATION

Plants have been a symbol for food and shelter<sup>08</sup>. For landscaping, plants act as a frontage, continuation of the building and focal points for views<sup>09</sup>. When applied to a façade, greening provokes interest and stimulation due to understanding it as a resource for food, insulation, camouflage, and part of a larger system<sup>10</sup>.

---

*NATURAL  
MATERIALS*

Reveals the process of aging and wreathing; this helps to visualize the synergies and movements of nutrients within a natural process<sup>11</sup>.

---

*VIEWS AND  
VISTAS*

Exterior views with natural features deal with the feelings of confinement if in the correct proportion<sup>12</sup>. The views oriented has just as much importance as the size of the opening. If orientated to a geographical landmark, it gives the feeling of familiarity and a connection to place<sup>13</sup>. When looking out onto an exterior or interior view, we make overall assumptions of the space. If a view is to break into layers, that could reflect islands of socialization<sup>14</sup>; a view wide open bring vulnerability<sup>15</sup>. Alternatively, a view could only have the focus of the desired location, creating the shortest path in our heads to conserve energy<sup>16</sup>. Views work simultaneously with sound. If sound and sight do not match, it could cause anxiety. For example, the threshold of a hallway is 50 feet (any longer and the qualities become uncomfortable)<sup>17</sup>.

---

*FIRE*

Is one of the humans' inventions of controlling nature<sup>18</sup>. With ancestral relations to warmth, movement, colour, and food; the fire now celebrates comfort and civilization<sup>19</sup>.

---

**FIGURE [30]**

*Maggie Centre, by Foster + Partners. With an overlay to show the corridor open to interstitial space at a variety of scale. All while supporting one's well-being. Interpretation and overlay by author.*

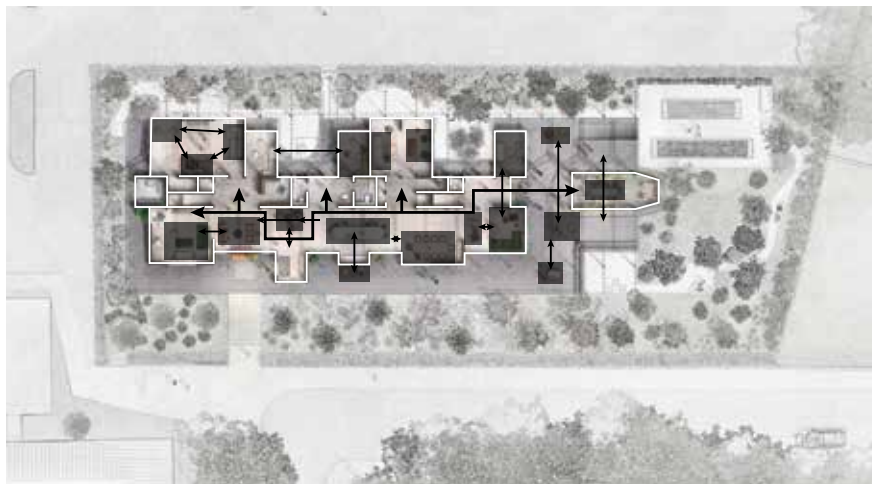
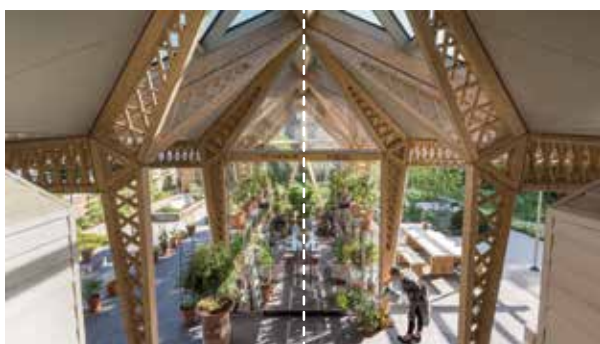


FIGURE [31]

*The Maggie Centre's greenhouse that was overlayed with its biophilic qualities in mind. The real success could be the combination of these considerations during the design process. Interpreted and overlay by author.*



[SYMMETRY]



[GEOMETRY]



[PROPORTION]



[GREEN PROGRAM]



[VIEWS]



[NATURAL LIGHT]

**GEOLOGICAL  
LANDSCAPE**

When our spaces connect to the ground through sight and sound, we have the assumption of rootedness to the landscape<sup>20</sup>. Earth can transfer thermal qualities and resonate not just with the hands, but with the feet.

**HABITATS AND  
ECOSYSTEMS**

By showing the cooperative relationship of a natural system with a building gives an ecological connection without being<sup>21</sup>.

**BOTANICAL MOTIFS**

Symbolize or give the distinction of a natural element. Capitals, supports, arches, roofs, domes, and curvatures transform a space into natural ornamental features<sup>22</sup>.

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## NORTHERN WELL-BEING

In the process of translating medical research to architectural application, a site was selected within a community where it could prove to have a significant impact on a population's well-being. The argument is that such a typology that crosses OB and midwife program could benefit the long-term fitness by trying to "clear the slate" of epigenetic tags on the DNA. Therefore, a location within the City of Sudbury was selected. Being considered Northern Ontario, Sudbury has many applying attributes to benefit a program that relies on biophilic theory (i.e., views and vistas of natural landscapes). Sudbury has multiple districts, with the downtown core arguably being the central node that serves this sprawl of population. A site was selected between this centre and the city's main hospital, Health Science North (41 Ramsey Lake Road), known as the Bell Park area. The property is currently an abandoned site of the former St. Joseph's Hospital (700 Ramsey Lake Road) that is partially demolished. [32]. This site has multiple attributes (on-site and in proximity) that would benefit the future population. It was decided that the existing infrastructure would not be used for this thesis. As the proposed typology requires an innovated, new, and intelligent architecture that would seem unfit if bound to an older institution. With the building removed and the bedrock exposed, this site and the Greater Sudbury area provides the following opportunities:

## HEALTH STATISTICS

Sudbury's health statistics can arguably be linked to epigenetic modifications that cause the rising of inheritable disorders. Obesity is an example of a complex disorder that affects Sudbury. In 2012, Sudbury was the second most obese city in Canada at 33.8% of its population<sup>01</sup>. This trend seems to be consistent across the country, as most Atlantic, Northern and Southwest Ontario cities are above the national average at 24.8%<sup>02</sup>. As a result, Health Science North has upgraded its lifts and beds to accommodate their obese patients<sup>03</sup>. This pattern is consistent when examining ischemic heart disease. Heart disease is the number one leading cause of death in Sudbury from 2002-2011<sup>04</sup>. As of 2013, Sudbury has had 467.6 per 100 000 of its population hospitalized for ischemic heart disease; the national average is 326.6 per 100 000 population<sup>05</sup>. As there are exponential amount of health issues within Sudbury and Northern Ontario, these statistics demonstrate that pharmaceutically medicine is only accommodating the problem and not implementing a solution.

A long-term solution could be to recognize the implications of our built environment; as identified by the World Health Organization's determinates of health, which states:

“Whether people are healthy or not, is determined by their circumstances and environment. To a large extent, factors such as where we live, the state of our environment, genetics, our income and education level, and our relationships with friends and family all have considerable impacts on health...”<sup>06</sup>

## GREEN PROGRAM

Since the re-greening efforts in Sudbury in 1978<sup>07</sup>, the available foliage and nature paths located in Bell Park make this site an attractive choice, primarily due to its proximity to Health Science North: Sudbury's central medical hub located near Bell Park and Ramsey Lake. This adjacent area offers many programs that would promote a healthy lifestyle, which includes physical activities and family-friendly social spaces. Bell Park is 45 hectares on the west shore of Ramsey Lake. There are multiple paths within the park (accessible by foot, bike, wheelchair) that link the beach, concession building, children's play park, gazebos, and the Grace Hartman Amphitheater [33]. In the winter, this program is extended onto the lake with the skating path. These paths extend across the shoreline to the Ramsey Lake Boardwalk connecting Science North (across from Health Science North), the Yacht Club, the Northern Water Sports Centre and the Lily Creek Boardwalk [34].

## VIEWS AND VISTAS

A benefit of situating the project on site of St. Joseph's Hospital is the vast topography which allows for multiple views and vistas. These views extend beyond Bell Park [35] and can be divided into three levels to get a better idea of how to position program onto the site. Each level offers a different range of views. The views can be categorized into either “people,” “city,” and “nature”; all of which have a significant impact at a cognitive level. Level 1, which is located below the treeline at the lowest point of the site and connects to the Bell Park Paths has views mostly to nature. Level 2, is at street level and above the park's treeline. The views offered provide a connection to the lake and a direct view to Laurentian University's campus (on

Ramsey Lake), and the Ramsey Lake shoreline. When not directed to the lake, the street level connects the site to the surrounding neighborhoods of Kingsmount-Bell Park; consisting predominantly of a middle-class demographic<sup>08</sup>, mostly married and approximately 50% with children<sup>09</sup>. The third level is at 2 storeys above the street level. At this height, there is a 360 view across the city (i.e., Health Science North, Science North, the boardwalk, Bridge of Nations, downtown, and Vale's Smoke Stack).

## NORTHERN HEALTH CAPITAL

Sudbury is Northern Ontario's health hub and serves the outlying areas across the North Shore, Manitoulin Island, and French River area. These communities have a large French-speaking population, and located within an Anishinabek territory. Health Science North Hospital has a maternity ward that hosts 2000 births a year. The facility is comparable to traditional layouts of obstetric units. This large property has a full view of Ramsey Lake and was previously dedicated to the St. Joseph's Hospital where the building still stands. As stated earlier, this building was a part of an older program of medicine and will not be used within this new typology.

## NOSM AND MIDWIFERY

The post-secondary professions within Sudbury can support that of an exclusive obstetric program. The Northern Ontario School of Medicine (NOSM) is a non-profit corporation which serves the faculty of medicine for Laurentian University<sup>10</sup>. The MD program not only educates the students for a career in medicine, but also trains them to effectively work in northern, urban, remote, Indigenous, and Francophone communities<sup>11</sup>; precisely the demographic that would serve this new typology. The future OBs of Sudbury would only satisfy one of a few birth plans. Mother's may choose to go with a midwife. Laurentian University also has a midwife that offers a 12-week placement during their education<sup>12</sup>. For midwife opportunities within the city, there are a few available with some catering to local Indigenous health at the Shkagamik-Kwe Health Centre<sup>13</sup>. Understanding the multiple opportunities with birth plans in Sudbury has opened the program to both sets of staff to serve the individual user, instead of the program build for the staff.



---

FIGURE [32]

*Drone footage of the existing St.  
Joseph's Hospital's conditions.  
Photographs by Tony Mai.*

[VIEW TO WEST]



[VIEW TO EAST]



[VIEW TO NORTH]



FIGURE [34]

*Extended map of adjacent hospital  
on Paris Street. Scale not applicable.*

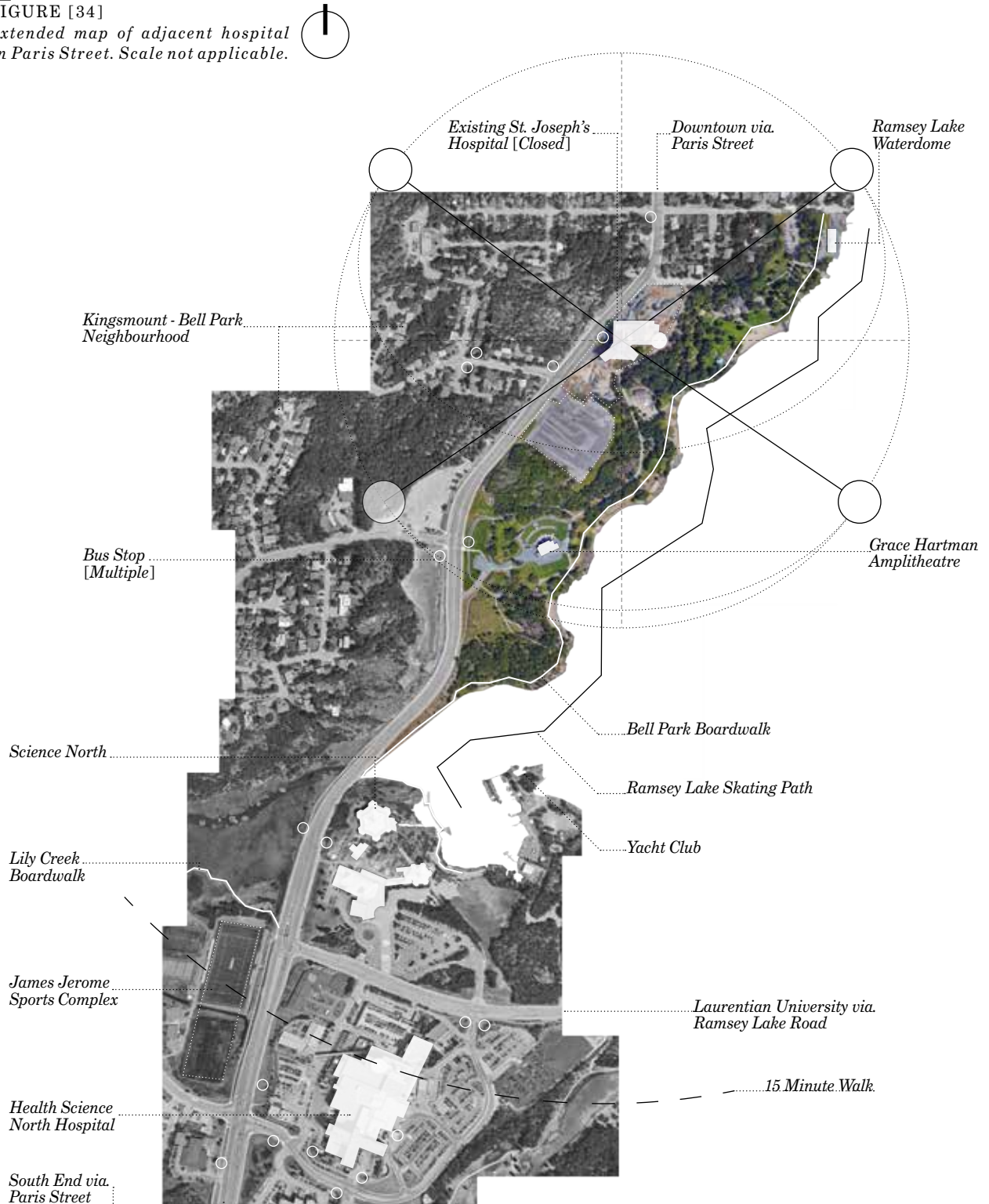
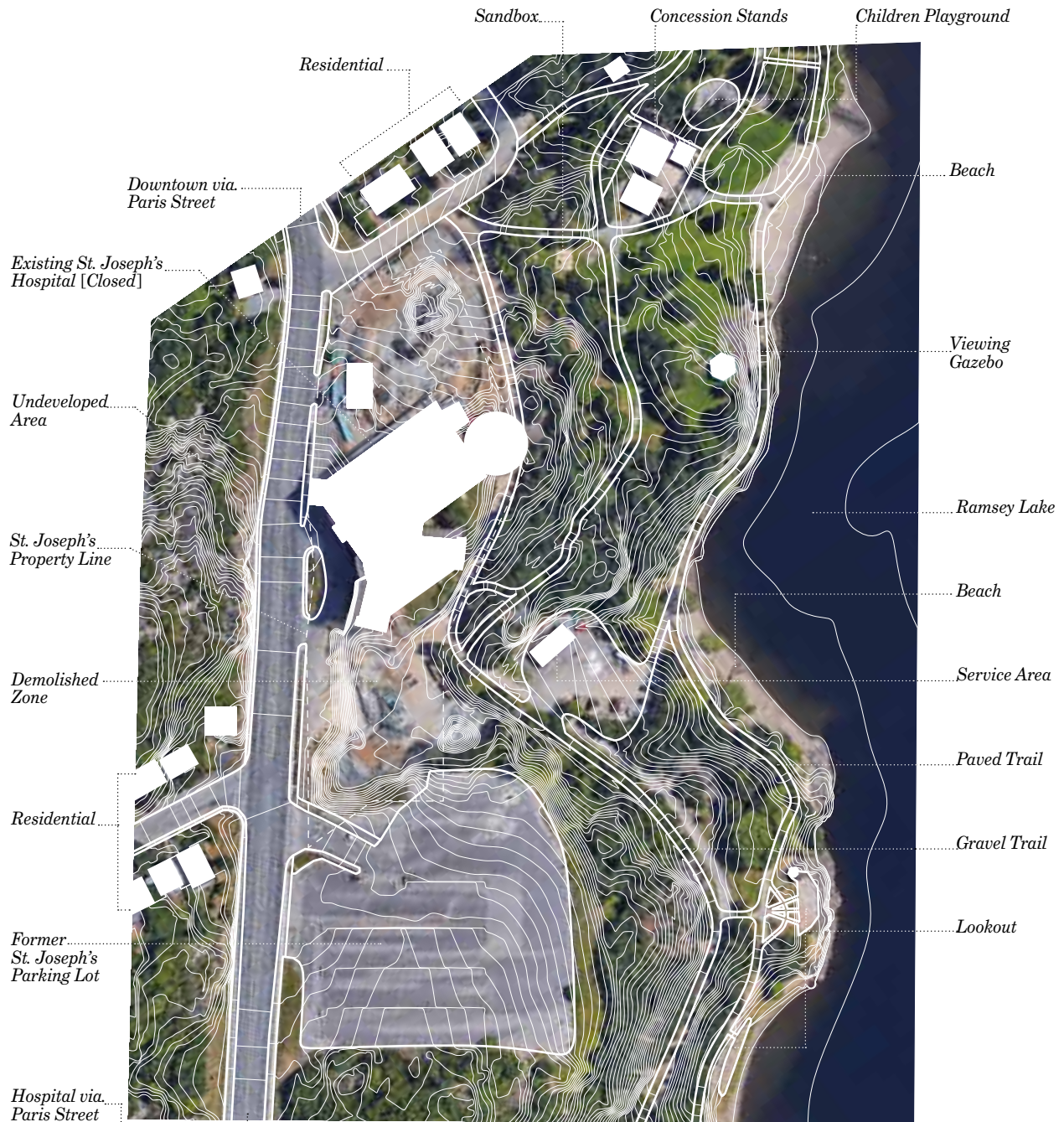


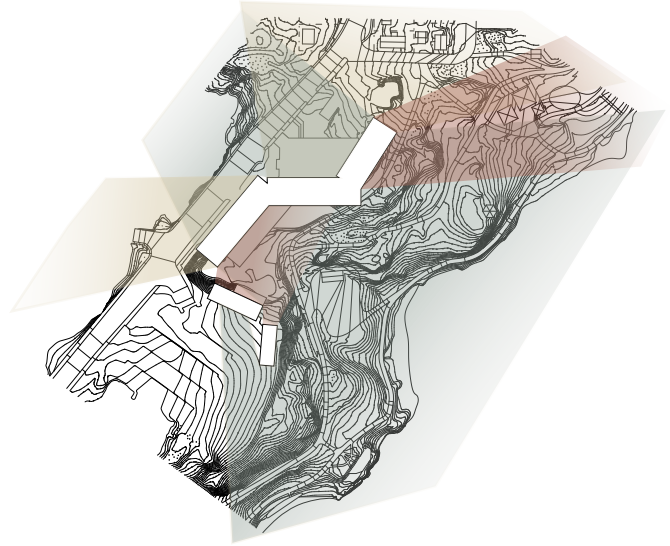


FIGURE [33]

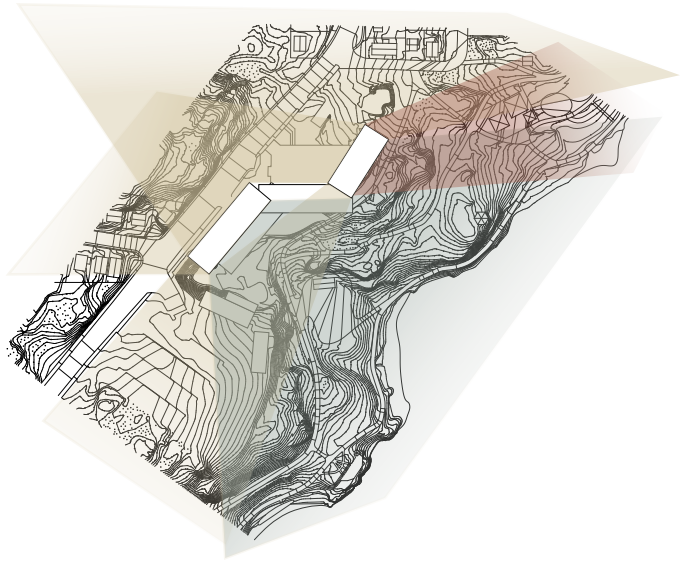
Map of adjacent programs that connect through Bell Park. Scale not applicable.



[HIGHEST LEVEL / 2 STOREY]



[MIDDLE LEVEL / STREET]



[LOWEST LEVEL / PARK PATH]

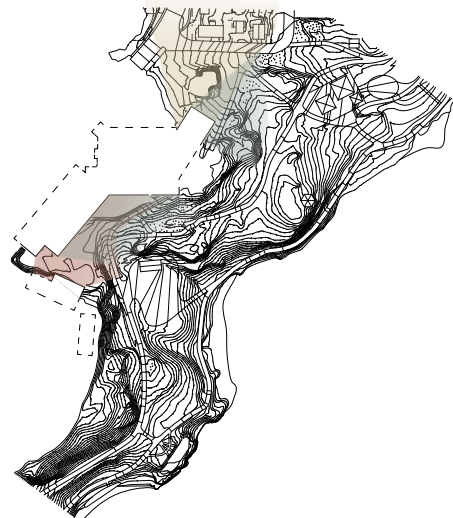


FIGURE [35]  
Site map displaying the variety  
of orientations at different levels.  
Scale not applicable.



## ENDNOTE

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- 07 "Regreening Program," City of Greater Sudbury, accessed April 27, 2018. <https://www.greatersudbury.ca/live/environment-and-sustainability1/regreening-program/ArcGIS>, "Demographic Data in the City of Greater Sudbury," City of Greater Sudbury, accessed April 27, 2019. <https://sudbury.maps.arcgis.com/apps/MapSeries/index.html?appid=2624ebe80fcc435d993f446d66920f51>
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CBC Radio, "Indigenous midwives now available in Sudbury," Shkagamik-Kwe, accessed April 27, 2019. <https://www.skhc.ca/project/native-health-action-plan-released-sudbury-copy/>



PART III





## SYNTHESIS

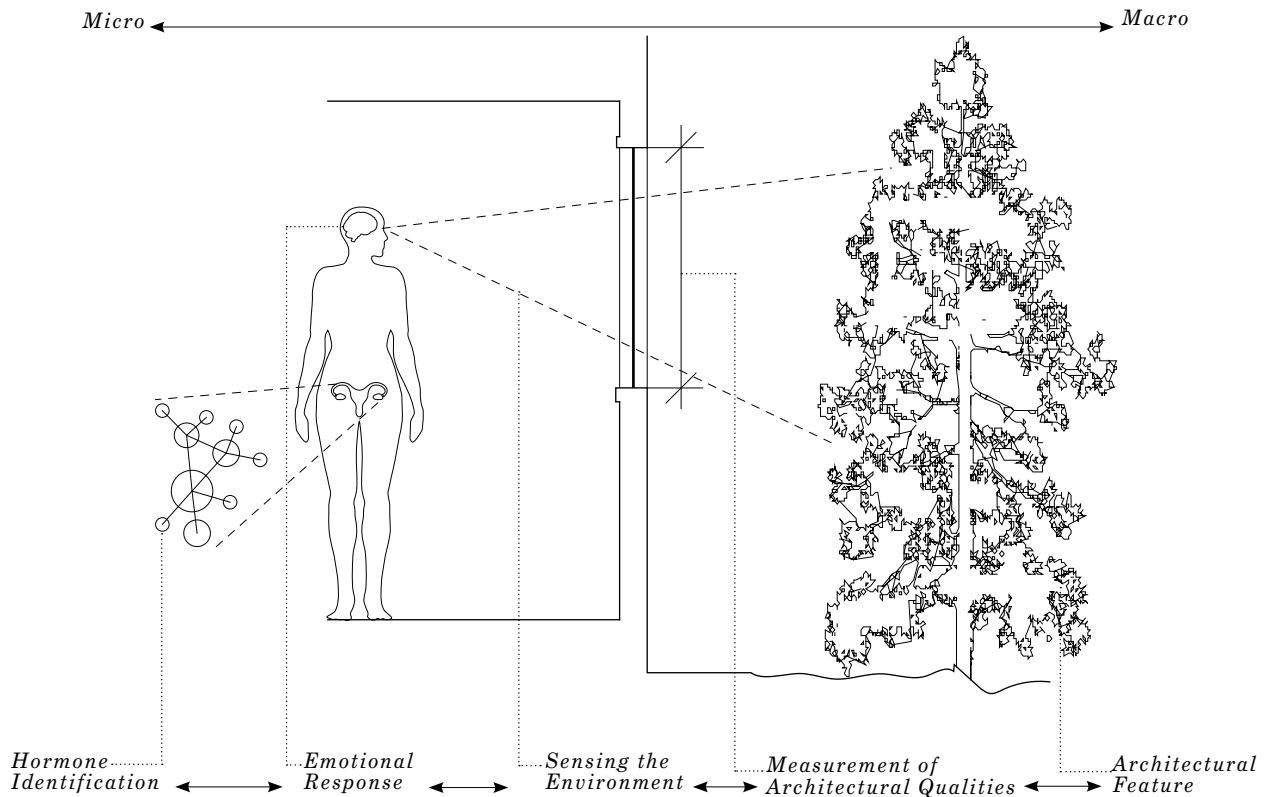
This thesis' primary methodology was to cross-analyze research amongst multiple disciplines; resulting in the synthesis of interventions from the micro to the macro scale [36]. This chapter will review the foundation that established the design process.

### 3 TRIMESTERS INTO 5 STAGES

FIGURE [36]

*Diagram legend showing the scales for the synthesis inventions. Illustrated by author.*

With an understanding of the previous sections of the interchanges within the female body, it seemed logical to review the organization of fetus development through the trimesters. By reviewing the hormonal stages and their milestones, the timeline of pregnancy and postpartum was divided into 5 stages [37]. These stages and their associated hormonal identification, emotional response, and additional behavioural notes are as follows:



## FIGURE [37]

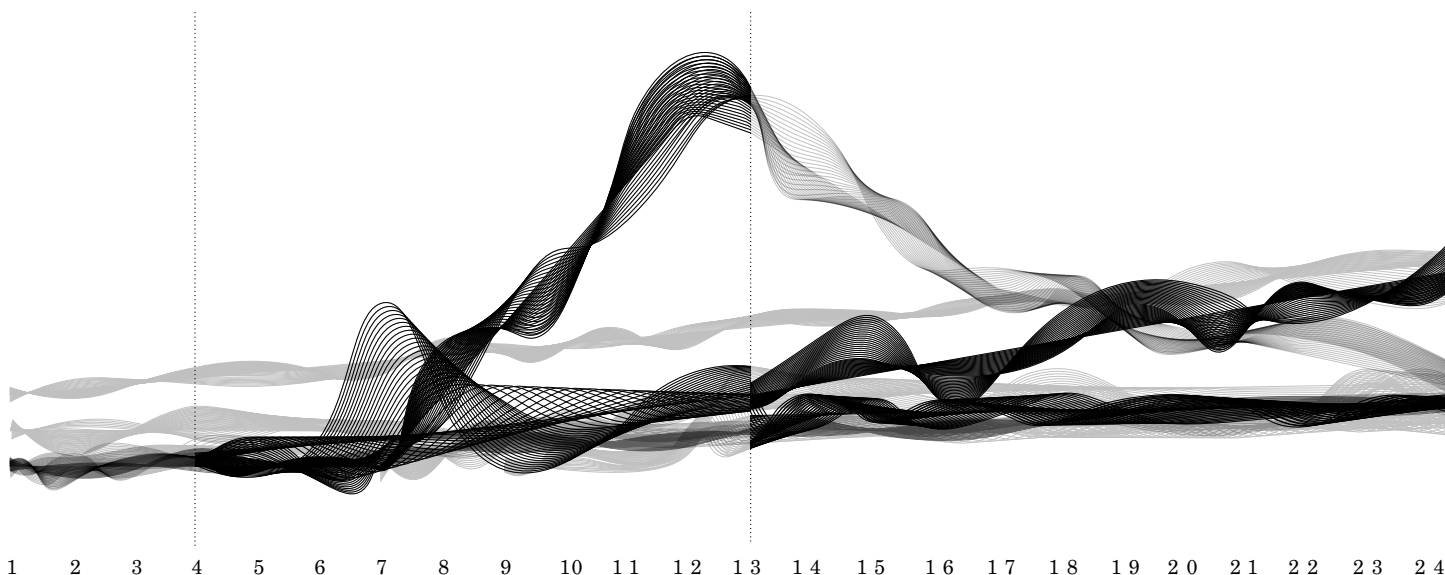
*Diagram of a pregnancy hormone levels and divided into the 5 stages. Interpreted and illustrated by author.*

**STAGE I [WEEK 4 - 13]**  
 [PROGESTERONE / hCG]  
 [BORED / SAFE]

This period is most vulnerable for fetal development as the cells are forming the axis and nervous system<sup>01</sup>. Progesterone and hCG make the mother more sensitive to morning sickness and being off-balance<sup>02</sup>. Therefore an overstimulating maternal environment could be detrimental to the lasting effects of the newborn.

**STAGE II [WEEK 13 - 26]**  
 [ESTROGENS / hPL]  
 [VIGILANT / SAFE]

The placenta secretes the estriol for the fetus; this makes the mother more vigilant. With the female easing out of morning sickness, she has more energy to burn off. Pregnant women can develop their muscular system, joint mobility, motor skills, and metabolism when visually seeing the need for locomotion<sup>03</sup>; showing the importance of interconnecting views and associated programs.



**STAGE III [WEEK 26 - 29]**  
 [CORTISOL]  
 [VIGILANT / STRESSED]

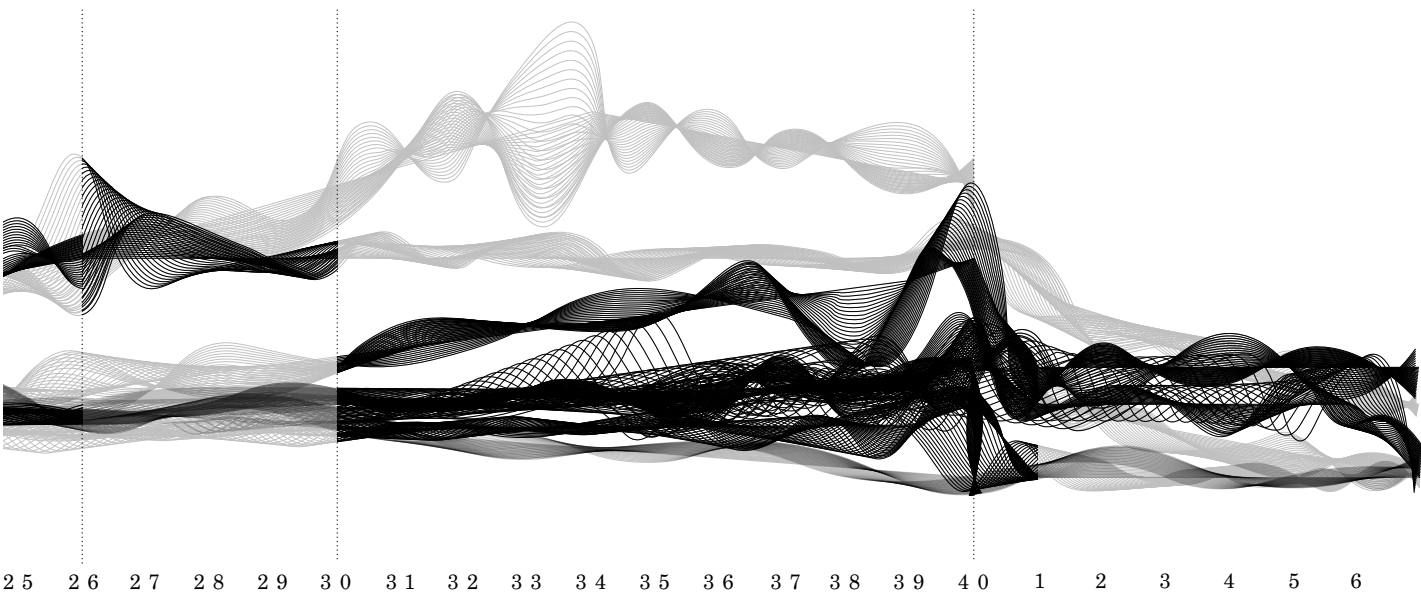
At week 26 cortisol is needed for the lungs to develop further. The sensorial information received from the exam room area will play a critical role and could encourage healthy rises in cortisol. As cortisol has been an association to the feeling of stress, the architecture would not associate stress with fear but as moments of awe with spatial recognition. Therefore, behaviours such as “wall hugging” found in cognitive architectural theory can be used<sup>04</sup>.

**STAGE IV [WEEK 30 - 40]**  
 [OXYTOCIN / PROGESTERONE /  
 PROLACTIN]  
 [VIGILANT / BORED / SAFE / AROUSED]

As the final stretch in the pregnancy, the mother is preparing mentally and physically for the labour. A mother's rise in progesterone helps her to stay calm and mentally more vigilant of her surroundings. As well as oxytocin pathways created, it is vital that a woman feels confident of her strength during pregnancy to ease the pain. Moments to create social interactions would be critical and to help women who suffer from autonomy withdrawal syndrome (that causes one not to be able to trust with the need of seclusion)<sup>05</sup>. Taking people out of their social environment is unnatural<sup>06</sup>; by inspiring expecting mothers to socialize, there is the empowerment of women supporting women.

**STAGE V [WEEK 40 -  
 6 POSTPARTUM]**  
 [OXYTOCIN / PROLACTIN]  
 [VIGILANT / SAFE / AROUSED]

After the event of parturition, whether before or after the expected due date, the mother is bonding with her newborn and is trying to balance out hormonal levels<sup>07</sup>. Oxytocin and prolactin are prominently being used for nursing; as other hormones try to level out. These feelings of trust, safety, and vigilance bring back the importance of social spaces and the reliance on others during this time. As well, the act of “people watching” becomes essential as it expresses the mother's need to protect her young<sup>08</sup>.



## FLEXIBLE QUALITIES

After correlating a hormone with an emotional response, research was cross-referenced to find connections for reading the built environment for well-being. Connecting emotional responses to architectural qualities was done by an exercise of correlating keywords. An emotion with its well-suited synonyms was used ( found in an earlier chapter, Limbic System). They are as follows:

*BORED* [*TIRED* / *DETACHED*]

*AROUSED* [*INTERESTED* / *MOTIVATED* / *DISTRACTED*]

*STRESSED* [*FEARFUL* / *ALARMED* / *ANXIOUS* / *CHAOTIC*]

*SAFE* [*SECURE* / *RELAXED* / *TRUSTING*]

*VIGILANT* [*ATTENTIVE* / *CONSCIENTIOUS*]

These emotions are triggered when our senses see qualities within the built environment<sup>09</sup>; although every response is unique, this connection of research is just a foundation to apply a design. A network diagram shows the connection of our senses reading the built environment before an emotional input [38]. Each emotional path was then inputted for each stage [39]. However, there is more than one emotion per stage, and for this, some outputs would have to outway the other. For example, Stage I has boredom and safety for an emotional response. When comparing the measurement of lux, boredom would need low light, as light has a reference for movement and circulation<sup>10</sup>; to the contrary, safety would suggest being well-lit to show any obstacles and predators before entering a space. In this case low light was the logical decision; due to the sensitivity for rest within Stage I because of morning sickness and the cells forming the fetus' nervous system<sup>11</sup>. Concluded that these connections made within these diagrams are not fixed but suggestive, and becomes a part of a tool kit for design.

When reflecting the 5 diagrams for each stage, there is an observation that some architectural qualities have more of a role than others (i.e., light's unit of lux and direction was interchanging more between phases than materiality's texture). In these conclusions, it was decided in order to simplify an infinite number of arrangements, to focus on the qualities affected frequently. In the case of the use of light and materiality, light is an easier adjustment for space by allowing

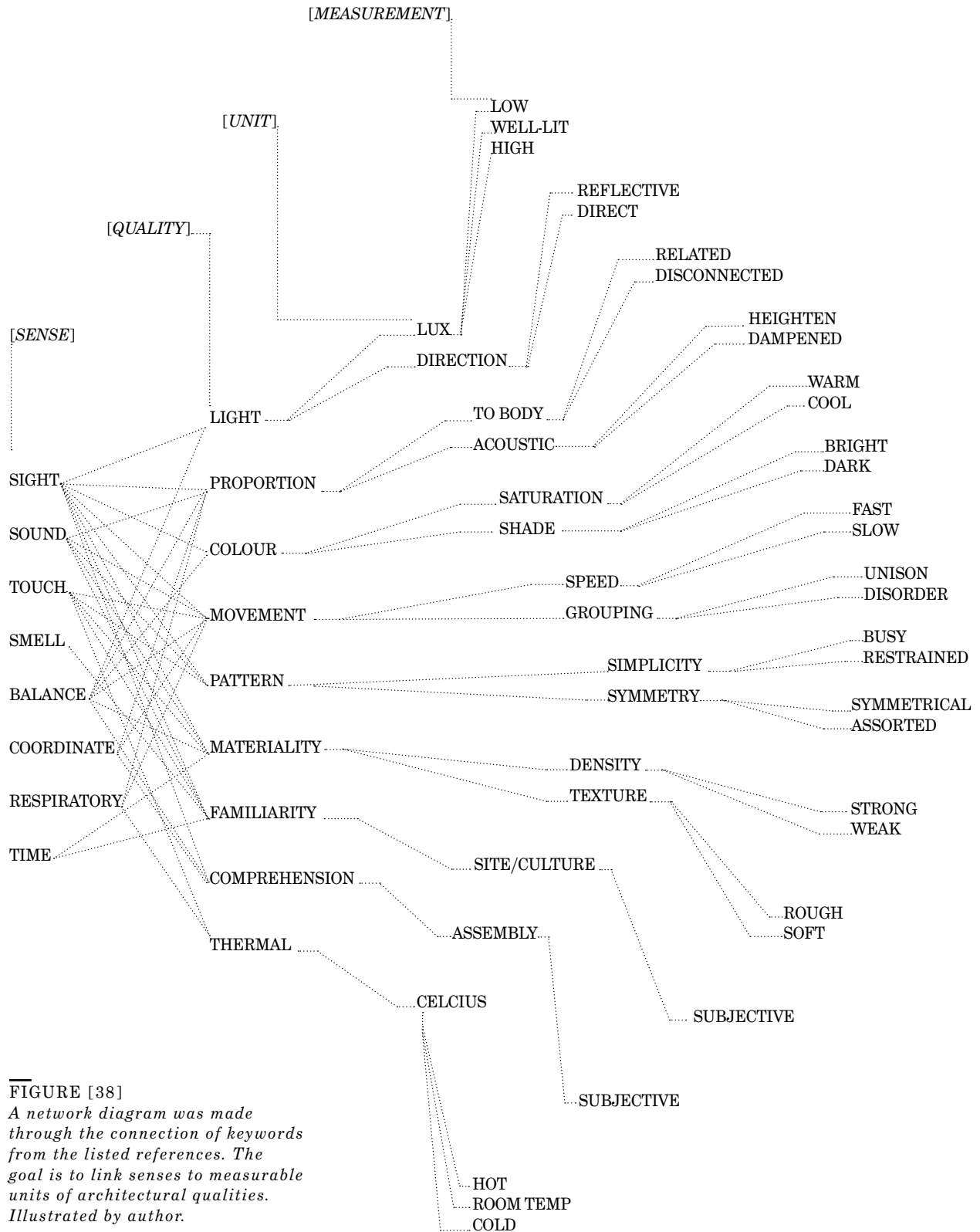
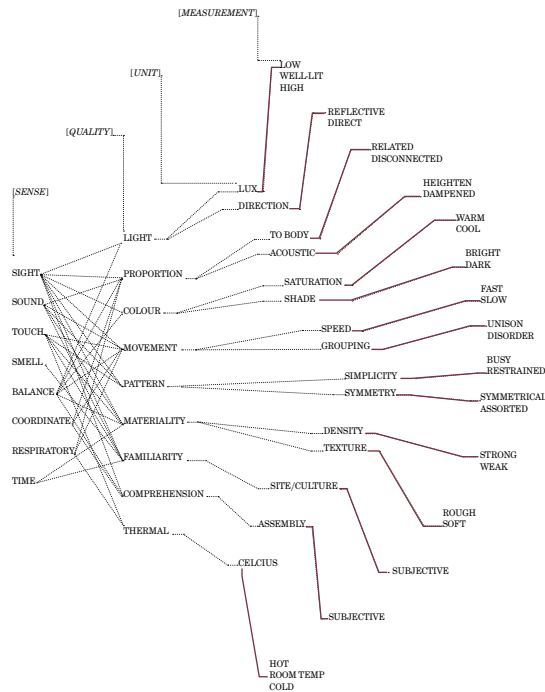


FIGURE [38]

A network diagram was made through the connection of keywords from the listed references. The goal is to link senses to measurable units of architectural qualities. Illustrated by author.

**STAGE I [WEEK 4 - 13]**  
 [PROGESTERONE / hCG]  
 [BORED / SAFE]



**STAGE II [WEEK 13 - 26]**  
 [ESTROGENS / hPL]  
 [VIGILANT / SAFE]

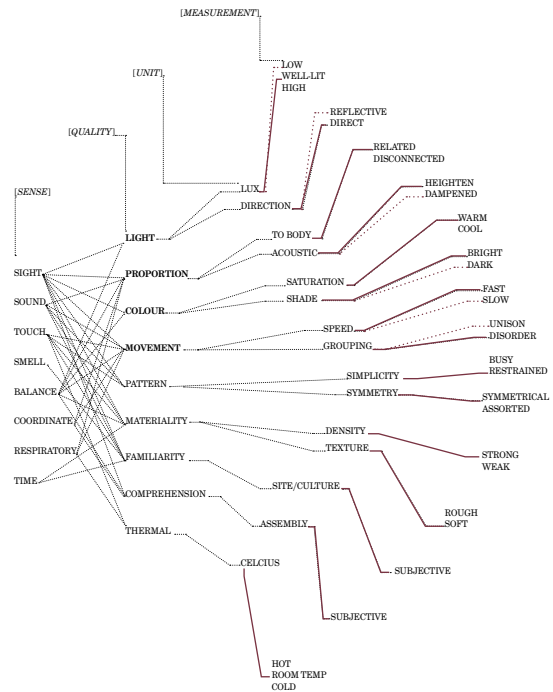


FIGURE [39]

A network diagram was made through the connection of keywords from the listed references. These have been used to connect the emotional requirements of each stage. As well, the comparison of the previous stage. Illustrated by author.

for openings; materiality would be more challenging to become flexible as it is more fixed as a finish within a space. Therefore, these diagrams were further developed to display the current stage, the previous stage, and qualities that should be flexible. The flexible qualities are:

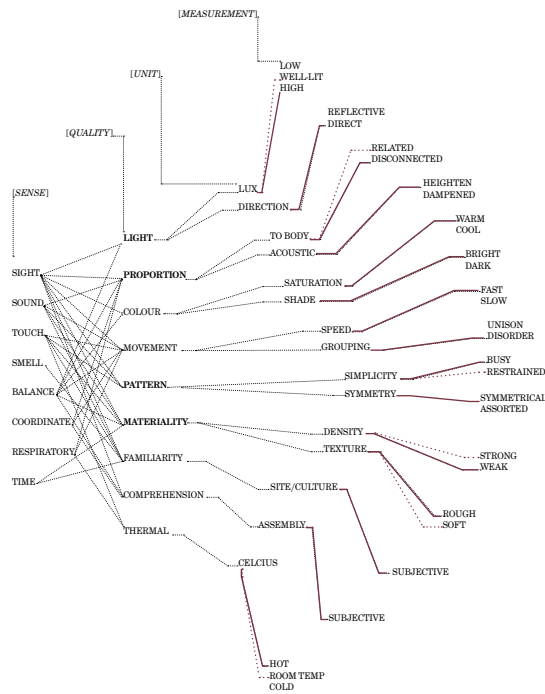
**LIGHT**

**PROPORTION**

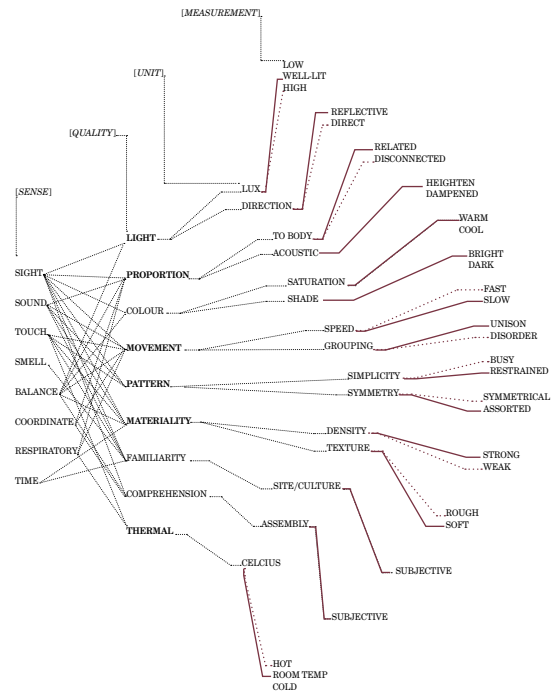
**MOVEMENT**

Only having three flexible qualities will still bring many iterations of possible spaces. As well, having only three will simplify the interventions being used to change the space. Too many changes between each stage may bring confusion and unfamiliarity, which goes against the idea of pregnant women needing a stable home. The fixed qualities will still be included and identified within the design process. This synthesis will continue into the design of the room, the neighbours, and the site; completing the program of a new typology.

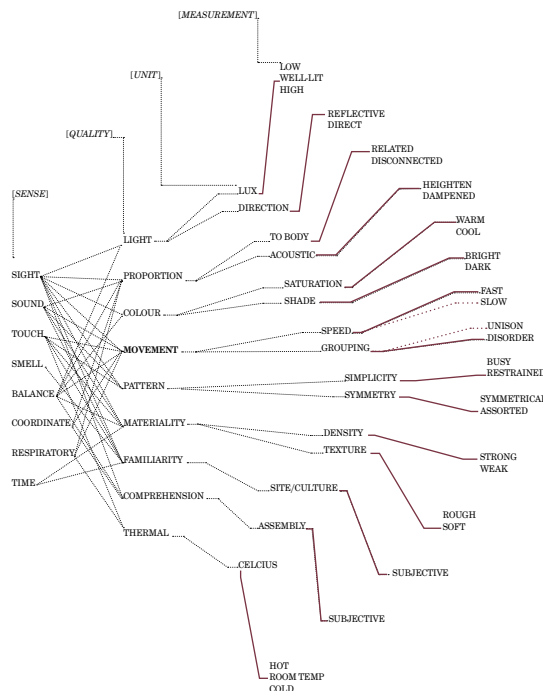
**STAGE III [WEEK 26 - 29]**  
 [CORTISOL]  
 [VIGILANT / STRESSED]



**STAGE IV [WEEK 30 - 40]**  
 [OXYTOCIN / PROGESTERONE/  
 PROLACTIN]  
 [VIGILANT / BORED / SAFE / AROUSED]



**STAGE V [WEEK 40 - 6 POSTPARTUM]**  
 [OXYTOCIN/PROLACTIN]  
 [VIGILANT / SAFE / AROUSED]







## ENDNOTES

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## THE ROOM

*If a single room had to assist the hormonal changes a woman experiences during her pregnancy, what would it look like, how would it transform?*

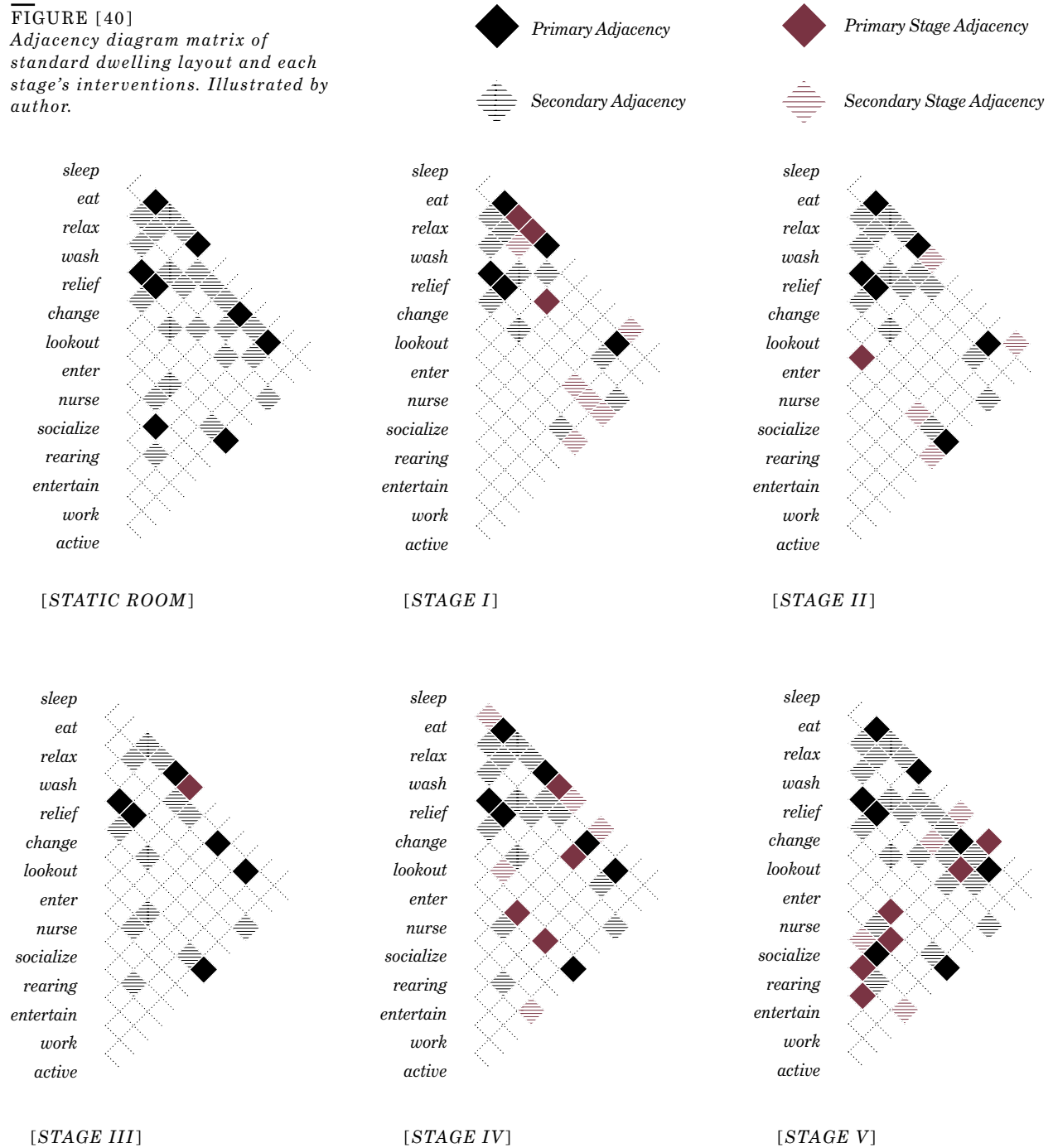
The question above launches the development of a new typology, a short-term residence for pregnant women. This program, as mentioned previously, is not for those women who have a comfortable home and support system; it is for those women who do not have a safe/dependable home or support. Iain McGilchrist stated in *Mind in Architecture* that the baby bird is as attached to the nest as the mother<sup>01</sup>; this concludes that this room will provide all the support required for her and her unborn child. This chapter will go through the process of designing and creating a single room that morphs into each stage's proper emotional response. As in the previous chapter, there is a drawn conclusion of specified qualities of architecture that would benefit from being flexible (light, proportion, movement). The next step is to make these qualities measurable within the architectural features of the room; starting with its functional adjacencies.

## FEATURES FROM FUNCTIONS

To create the functional adjacencies of a room, we first need to define what a function is. In this circumstance, the function will be related to the need of the user by an action, and not through the connection of furniture. Furniture may be used not for a single function but for multiple (i.e., a couch may be used to relax, hosting socialization, and be used to look out when next to a window). By looking at function as an action, adjacencies are linked closer to the architecture than to interior design. The compiling of several functions (including nursing and rearing) were placed into an adjacency matrix under the assumption that it is a static dwelling. The static dwelling gave the baseline of what is typical. The matrix shows the adjacencies of what is primary (i.e., sleep and change), secondary (i.e., active and wash), and not ideal (i.e., eat and relief). All these adjacencies should be noted as one scenario. However, any of these adjacencies may be different amongst individuals. This matrix tool was then adjusted for each stage's functional requirements, where the metamorphosis of space is seen [40].

The toolkit currently established for the room design is hormone identification, emotional response, flexible qualities, and the functional features of the space within each stage. The last piece of this toolkit was done by continuing a diagrammatic methodology. These diagrams have been developed through an algorithm that

FIGURE [40]  
*Adjacency diagram matrix of  
 standard dwelling layout and each  
 stage's interventions. Illustrated by  
 author.*



## FIGURE [41]

*The last piece of the toolkit is the diagram developed through an algorithm to visualize the connection of architectural qualities to their functional adjacencies. Illustrated by author.*



[Light] Larger translates to a qualitative change (lux/direction)



[Movement] Thicker line weight translates to a qualitative change (speed/grouping)



[Proportion] A grouping of functions translates to a qualitative change (to body/acoustics)

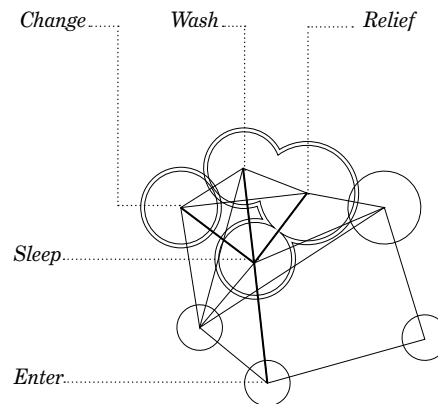
visualizes the connections of the architectural qualities and functional adjacencies [41]. As the spaces morph from the flexible measurements of light, proportion, and movement, there is an abstract visualization of complexities that implicates the design iterations.

## STAGE I [WEEK 4 - 13]

HORMONE  
[PROGESTERONE/hCG]

EMOTION  
[BORED / SAFE]

QUALITIES  
[ LIGHT | REFLECTIVE/ LOW LUX]  
[PROPORTION | CONNECT BODY / ACOUSTICS DAMPENED]  
[MOVEMENT | SLOW / UNISON]

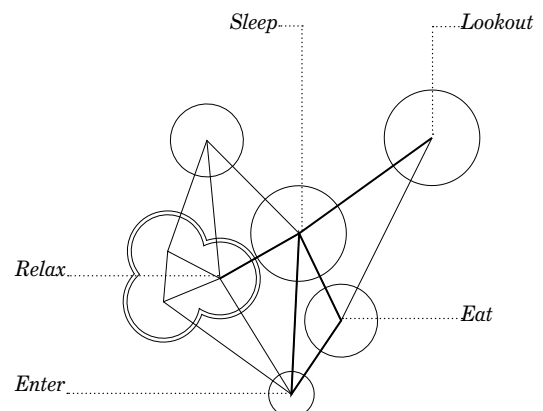


## STAGE II [WEEK 13 - 26]

HORMONE  
[ESTROGENS/hPL]

EMOTION  
[VIGILANT / SAFE]

QUALITIES  
[LIGHT | **WELL-LIT / DIRECT**]  
[PROPORTION | **CONNECT BODY / ACOUSTICS HEIGHTENED**]  
[MOVEMENT | **FAST / DISORDER**]

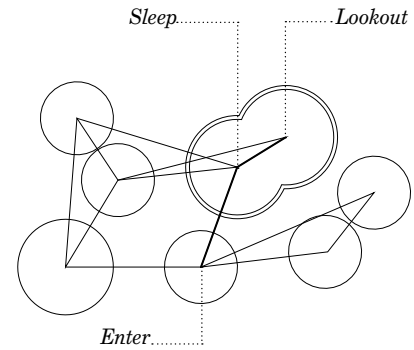


**STAGE III [WEEK 26 - 29]**

HORMONE  
[CORTISOL]

EMOTION  
[VIGILANT / STRESSED]

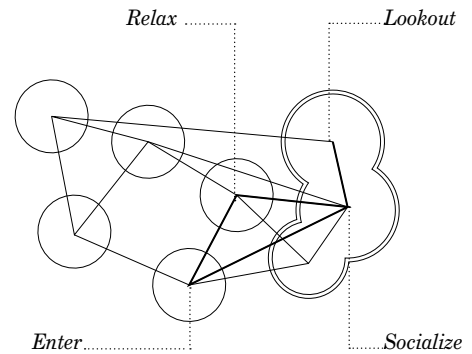
QUALITIES  
[LIGHT | **HIGH LUX** / DIRECT]  
[PROPORTION | **DISCONNECT BODY** / ACOUSTICS HEIGHTENED]  
[MOVEMENT | **FAST** / DISORDER]

**STAGE IV [WEEK 30 - 40]**

HORMONE  
[OXYTOCIN / PROGESTERONE / PROLACTIN]

EMOTION  
[VIGILANT / BORED / SAFE / AROUSED]

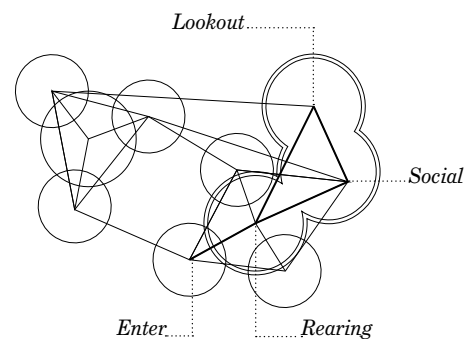
QUALITIES  
[LIGHT | **WELL-LIT** / REFLECTIVE]  
[PROPORTION | **CONNECT BODY** / ACOUSTICS HEIGHTENED]  
[MOVEMENT | **SLOW** / UNISON]

**STAGE V [WEEK 40 - 6 POSTPARTUM]**

HORMONE  
[OXYTOCIN / PROLACTIN]

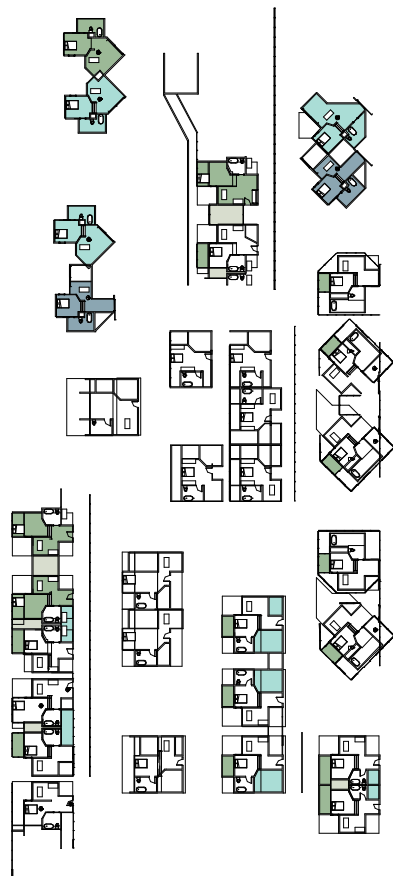
EMOTION  
[VIGILANT / SAFE / AROUSED]

QUALITIES  
[LIGHT | **WELL-LIT** / REFLECTIVE]  
[PROPORTION | **CONNECT BODY** / ACOUSTICS HEIGHTENED]  
[MOVEMENT | **FAST** / DISORDER]



## APPLICATION OF TOOLKIT

FIGURE [42]  
*Iterations of room layouts.*



Now that the design toolkit is complete, design iterations were developed through the process of rough sketches and 3D modeling [42] [44]. A major challenge was ensuring the design was not 5 separate static rooms, but a single flexible room that made strategic architectural changes that would not be overwhelming for the sensitive mother. By iterating through plan and section, simple architectural changes were used to adjust the reading of light, proportion, and movement. These include minor alterations in the subtle positioning of floors, walls, and ceilings within a double skin structure. Moving these planes reveals windows, layout changes, views, and program that have multiple measurable architectural qualities (i.e., a window increases lux, and depending on the orientation displays movement by the act of people watching). To further describe the double skin structure, this element was designed around a motif of the uterus. The uterus expands with the developing fetus within the mother who is exposed to the outside world. The fetus is floating in amniotic fluid that keeps them safe and regulates their bodily function (i.e., temperature)<sup>02</sup>. The uterus' role is to be a flexible space for the fetus that is exposed to its measurable qualities; like that of the flexible room.

Through multiple iterations, the final layout had flexible positions that are specific to each stage [43]. The room's layout accommodates the functional needs required through the different stages; as well as the support staff required to conduct check-ups and eventually assist in the birthing process. These include fixed features such as the bedside medical housing and interface display. This medical housing will contain support staff storage for check-ups, including an ultrasound machine. The interface display will assist the staff when conducting appointments, and will be available any time by the mother to allow her to see her stage status (see chapter Interface Threshold for more details). Lastly, the room's arrangement has a significant determination on the adjacent neighbour and their stage. It was decided to have flexible programs between each neighbour that could be accessed by her, the neighbour, both, or neither. The programs are a shared social space that would ideally encourage the neighbours to interact with one another. When not open to both neighbours, this space would accommodate guests and moments of isolation/privacy. The other program includes a waterbirth tub that

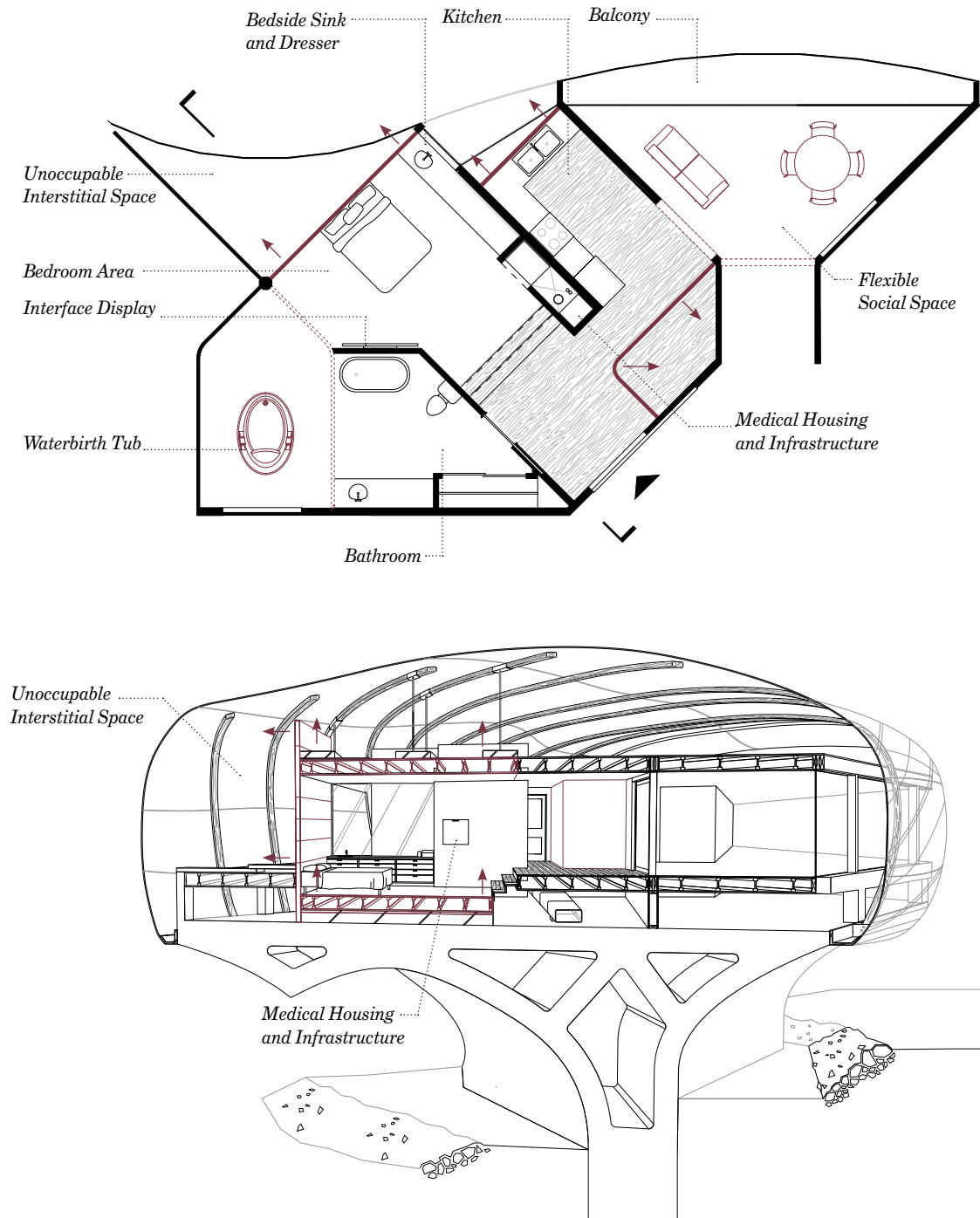


FIGURE [43]

*Floor plan and perspective section of short-term residence. Highlighting the flexible plates within the double skin structure. Illustrated by author.*

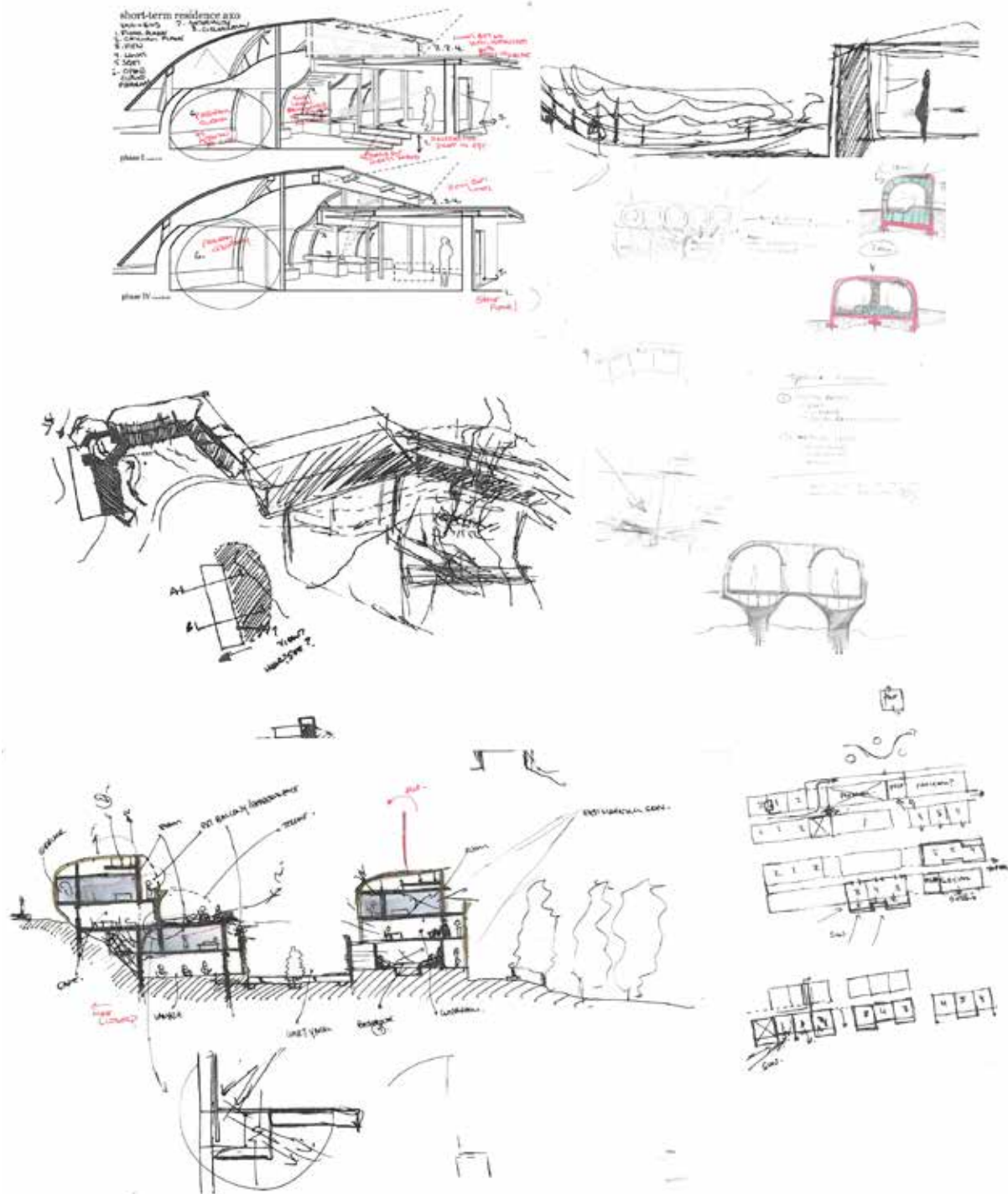
**NOTE | FLEXIBLE FEATURES  
ANNOTATED WITH COLOUR**

1 : 300

will never be accessible by both neighbours, but available if one were to be experiencing labour. When not in use, it is accessible through the hallway for support staff to prepare and sanitize. These options are further discussed in the later chapter *The Neighbour*.

FIGURE [44]

Hand sketches of initial design of the room. Drawn by author.





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THE 5 STAGES

The following pages will include the room at each of the 5 stages. Each stage is paired with a summary of its identified toolkit, the highlighted architectural change, and stage-specific function/program.

**STAGE I [WEEKS 4-13]****FIGURE [45]**

*Floor plan of the short-term residence's flexible architecture  
1 : 100*

*[Hormone Identification]*  
Progesterone  
hCG

*[Emotional Synthesis]*  
Bored  
Safe

*[Paired Program]*  
Morning sickness  
First set of check-ups

*[Qualities]*

Light	Reflective/ Low Lux
Motion	Slow / Unison
Proportion	Connect Body / Acoustics Dampened

*[Single View]*

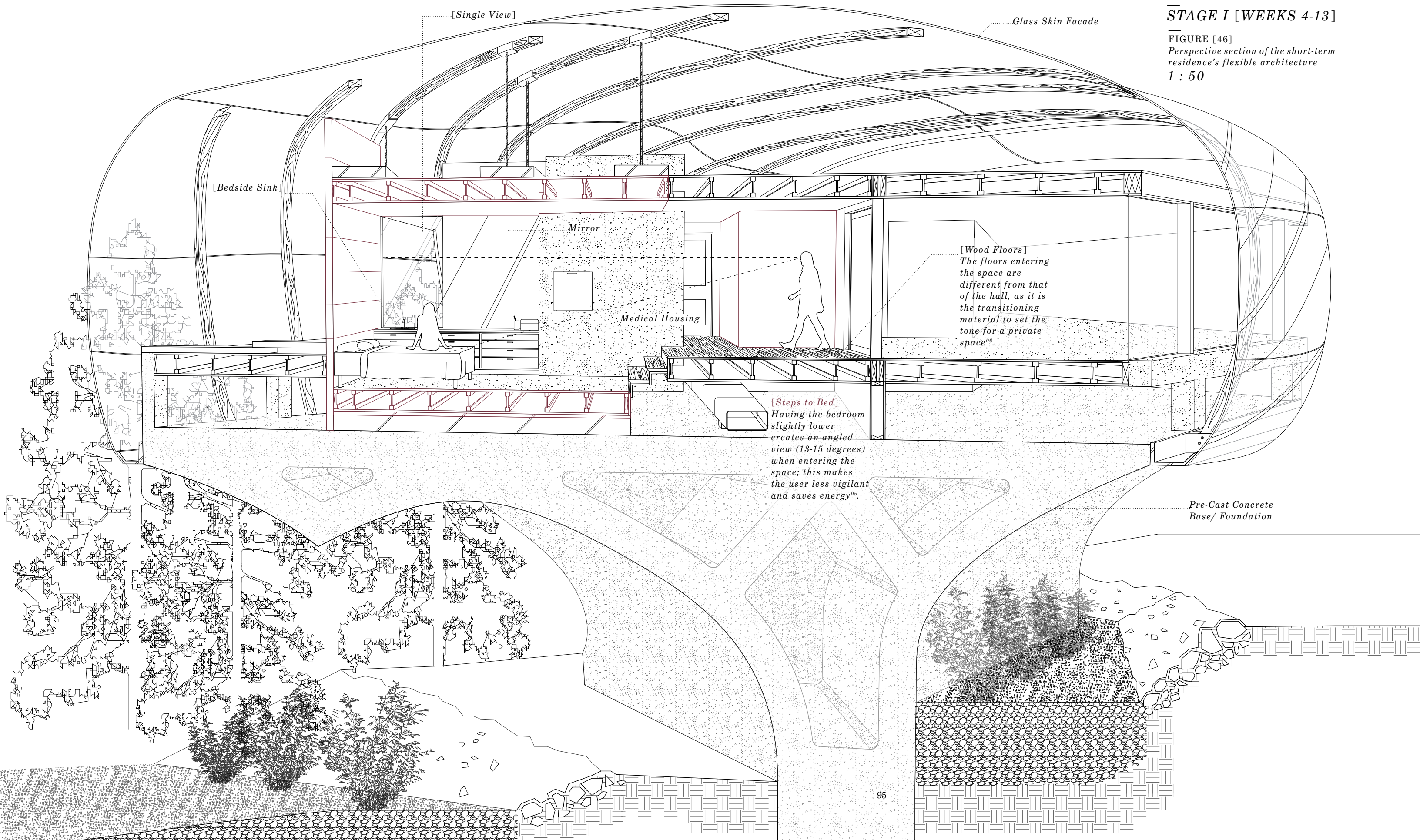
*The only view currently from the room is a single window at the bedside. A single light gives a phototropic response to relax in the bedroom during daylight hours<sup>03</sup>.*

*[Exterior]**[Bedside Sink]*

*Having the sink next to be the bed is for the issue of morning sickness during the first stage. The window is fixed to allow a grounding view through out all stages<sup>04</sup>.*

*[Interior]**[Blocking Kitchen]*

*The bumped out wall stops the visual of the kitchen at the entry, making the bedroom the main focus.*



[Single View]

Glass Skin Facade

[Bedside Sink]

Mirror

Medical Housing

[Wood Floors]  
The floors entering  
the space are  
different from that  
of the hall, as it is  
the transitioning  
material to set the  
tone for a private  
space<sup>06</sup>

[Steps to Bed]  
Having the bedroom  
slightly lower  
creates an angled  
view (13-15 degrees)  
when entering the  
space; this makes  
the user less vigilant  
and saves energy<sup>05</sup>.

Pre-Cast Concrete  
Base/ Foundation

## STAGE I [WEEKS 4-13]

FIGURE [46]  
Perspective section of the short-term  
residence's flexible architecture  
1 : 50

# STAGE II [WEEKS 13-26]

FIGURE [47]

Floor plan of the short-term residence's flexible architecture  
1 : 100

[Hormone Identification]

Estrogen  
hPL

[Paired Program]

Physical Fitness  
Check-ups

[Emotional Synthesis]

Vigilant  
Safe

[Qualities]

Light	<b>Well-Lit / Direct</b> <b>Fast / Disorder</b> <b>Connect Body /</b> <b>Acoustics Heightened</b>
Motion	
Proportion	

## [Kitchen View]

The wall behind the kitchen sink is smart glass that will become less opaque as it moves towards the exterior facade. In doing so the room is brightened and orientates a view to an active program.

[Exterior]

[Interior]

## [Light at Entry]

The flexible wall is inverted, a more direct light coming from the kitchen; steering her away from relaxing in bed.

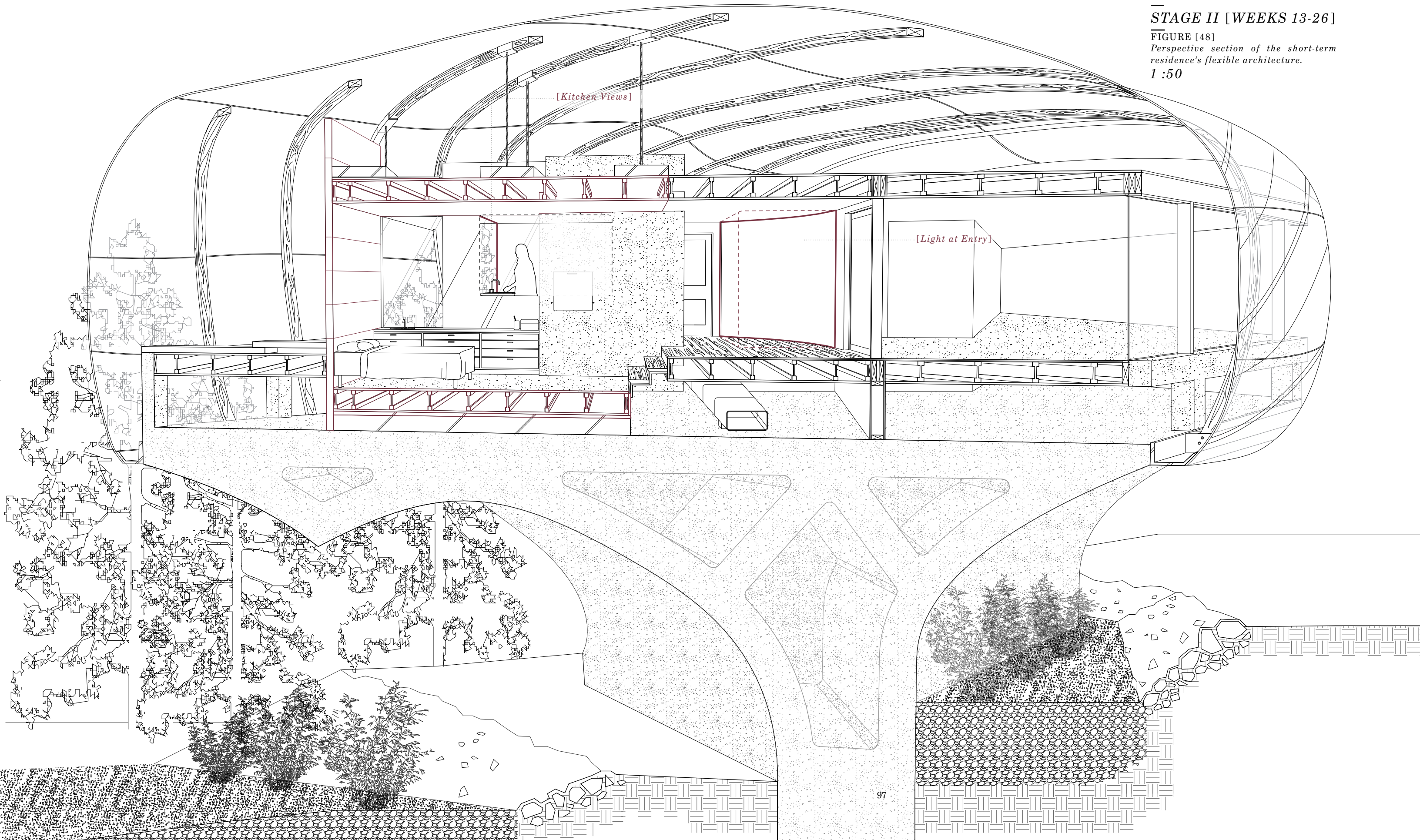


—  
**STAGE II [WEEKS 13-26]**

FIGURE [48]

*Perspective section of the short-term  
residence's flexible architecture.*

1 : 50



**STAGE III [WEEKS 26-30]**[Hormone Identification]  
Cortisol[Paired Program]  
Pre-Natal Classes  
Check-ups

FIGURE [49]

*Floor plan of the short-term  
residence's flexible architecture  
1 : 100*[Emotional Synthesis]  
Vigilant  
Stressed

[Qualities]

Light	High Lux / Direct
Motion	Fast / Disorder
Proportion	Disconnect Body /
	Acoustics Heightened

**[Panoramic View]***The wall behind the bed is smart glass that  
will become less opaque as it moves towards  
the exterior facade; widening the view of  
multiple programs<sup>08</sup>.*

[Exterior]

[Interior]



[Bent Laminated Wood Ribs]  
The structure holding the glass skin facade are bent laminated wood ribs. Having a natural building material in a curved form has connections in biophilic design for well-being<sup>9</sup>. Their repetition brings a fixed qualitative pattern.

[Panoramic View]

[Raised Ceiling]  
The ceiling has raised with the floor plate and has opened a glazed clerestory. The glazing still encloses the room but brings a reflective quality to the light as it filters through the space.

[Backless Bed]  
Humans are comforted with the protection of a wall behind them (referred to as wall hugging). Pushing the bed back gives a subtle feeling of restlessness<sup>10</sup>.

[Same Level]  
The lifting of the bed's floor plate is for functionality and to lift the head when entering (previously at the resting position of 15 degrees) to straight ahead, making the mother more vigilant of her space<sup>11</sup>.

STAGE III [WEEKS 26-30]

FIGURE [50]  
Perspective section of the short-term residence's flexible architecture  
1 : 50

**STAGE IV [WEEKS 30-40]****FIGURE [51]**

*Floor plan of the short-term  
residence's flexible architecture  
1 : 100*

**[Hormone Identification]**

Oxytocin  
Prolactin  
Progesterone

**[Emotional Synthesis]**

Vigilant  
Bored  
Safe  
Aroused

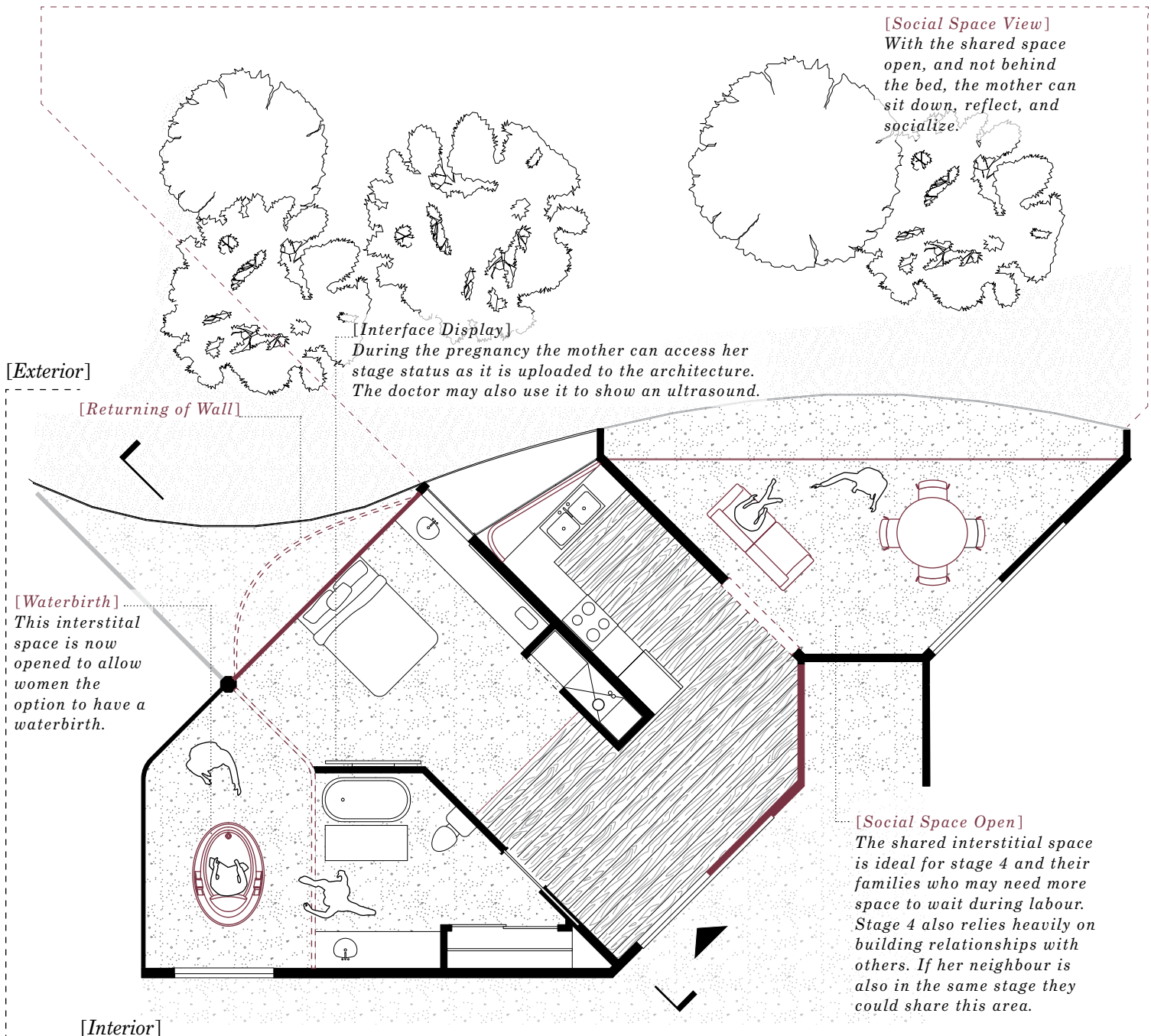
**[Paired Program]**

Pre-Natal Classes  
Frequent Check-ups  
Social Interactions  
Parturition Prep  
Possible High-risk

**[Qualities]**

Light  
Motion  
Proportion

Well-Lit / Reflective  
Slow / Unison  
Connect Body /  
Acoustics Heightened





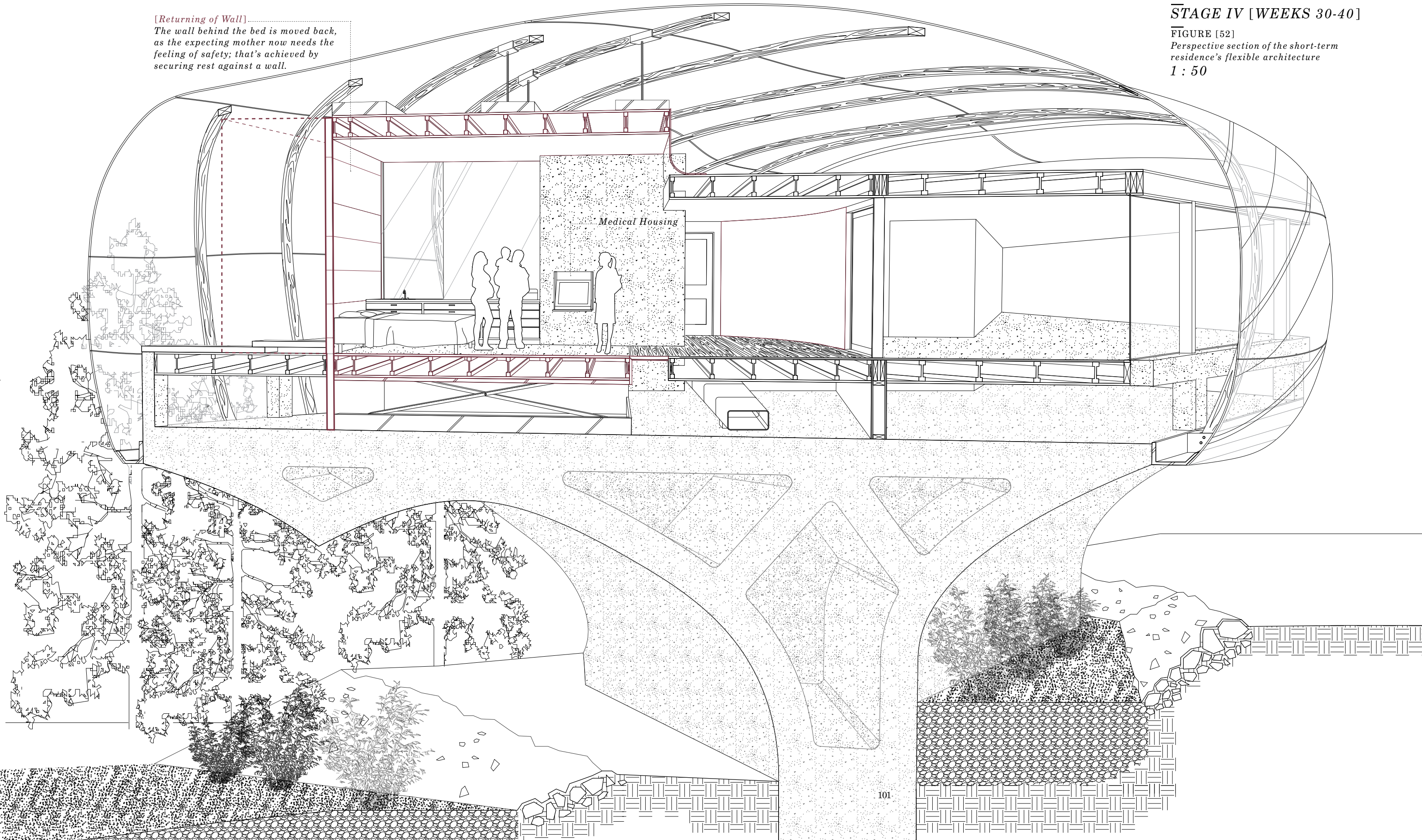
*[Returning of Wall]*  
The wall behind the bed is moved back,  
as the expecting mother now needs the  
feeling of safety; that's achieved by  
securing rest against a wall.

**STAGE IV [WEEKS 30-40]**

**FIGURE [52]**

*Perspective section of the short-term  
residence's flexible architecture*

*1 : 50*



# STAGE V [WEEKS 40 - 6 WEEKS POST PARTUM]

[Hormone Identification]  
Oxytocin  
Prolactin

[Paired Program]  
Nursing  
Recovery Check-ups  
Social Interactions  
Possible Neo-natal

FIGURE [53]

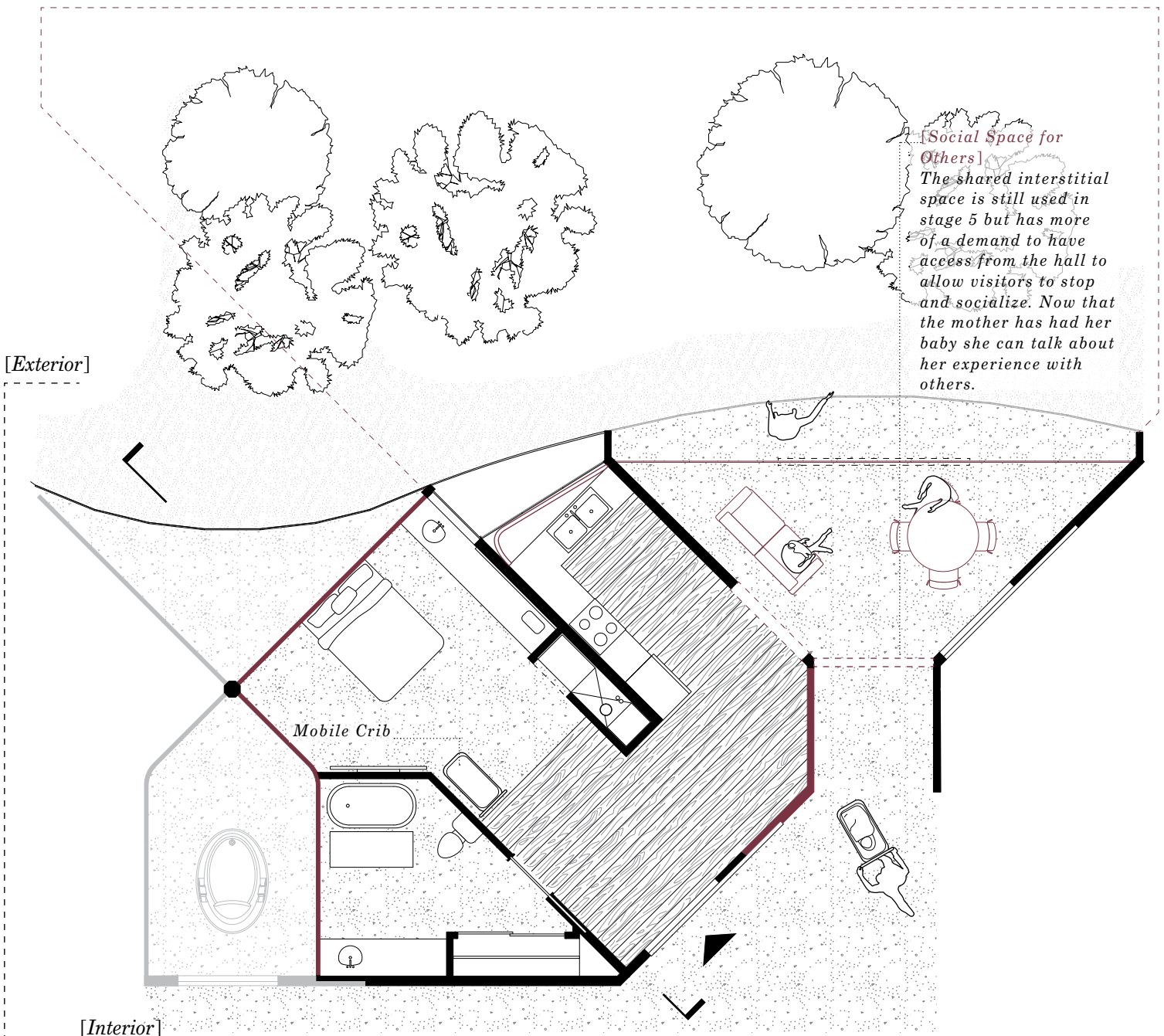
Floor plan of the short-term  
residence's flexible architecture

1 : 100

[Emotional Synthesis]  
Vigilant  
Safe  
Aroused

[Qualities]

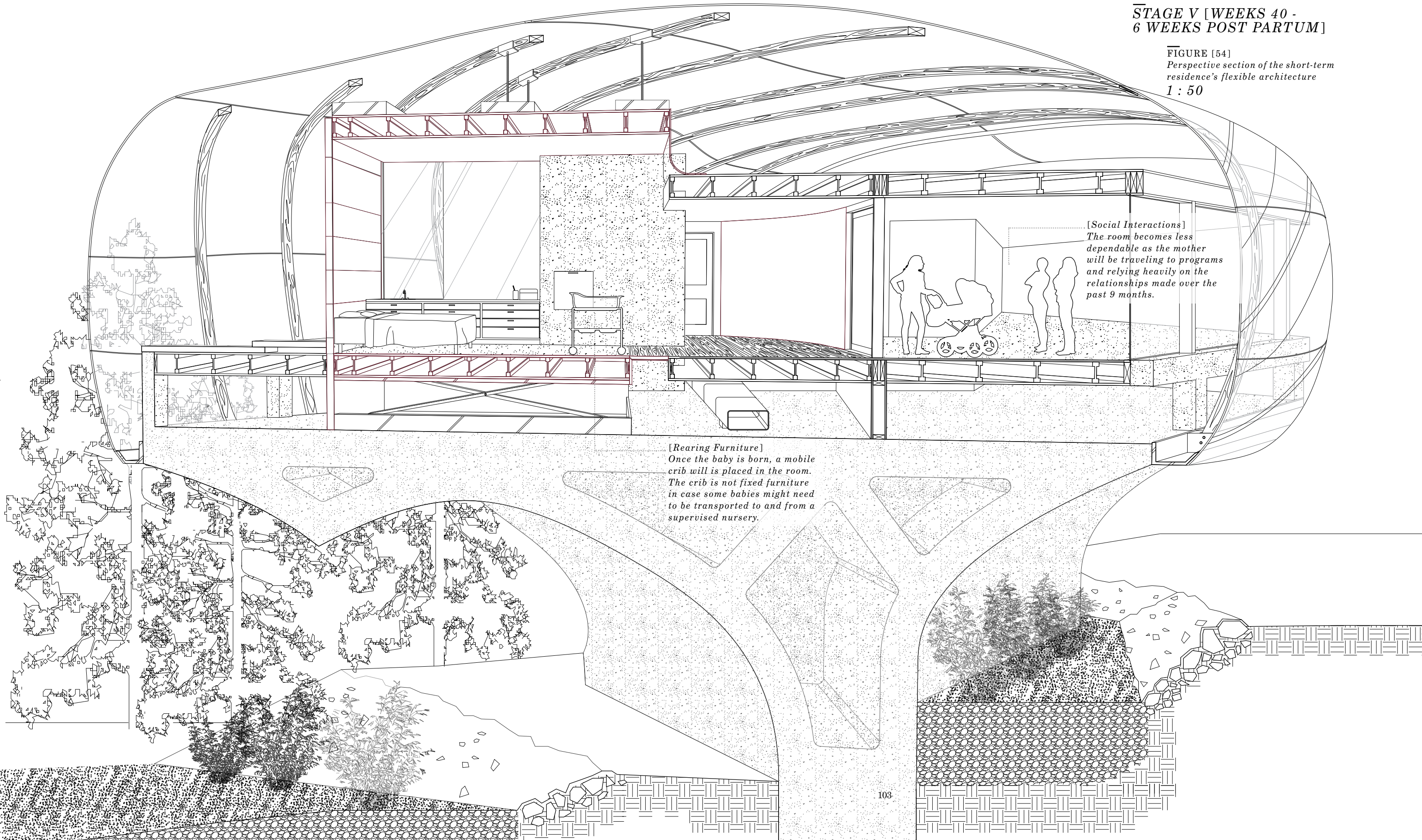
Light	Well-Lit / Reflective
Motion	Fast / Disorder
Proportion	Connect Body / Acoustics Heightened





STAGE V [WEEKS 40 -  
6 WEEKS POST PARTUM]

FIGURE [54]  
Perspective section of the short-term  
residence's flexible architecture  
1 : 50



[Social Interactions]  
The room becomes less  
dependable as the mother  
will be traveling to programs  
and relying heavily on the  
relationships made over the  
past 9 months.

[Rearing Furniture]  
Once the baby is born, a mobile  
crib will be placed in the room.  
The crib is not fixed furniture  
in case some babies might need  
to be transported to and from a  
supervised nursery.



## ENDNOTES

- 01 Robinson, Pallasmaa, *Mind in Architecture: Neuroscience, Embodiment, and the Future of Design*, 155.
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- 03 Alexander, Christopher, and et., *A Pattern Language: Towns, Buildings, Construction*, New York: Oxford University Press, 1977, 645.
- 04 Ibid, 835.
- 05 Sussman, A., and J. Hollander, *Cognitive Architecture: Designing for How We Respond to the Built Environment*, New York: Routledge, 2014, 26.
- 06 De Botton, Alain, *The Architecture of Happiness*, Toronto: McClelland & Stewart, 2006, 247.
- 07 Alexander, Christopher, and et., *A Pattern Language: Towns, Buildings, Construction*, 645.
- 08 Sussman, A., and J. Hollander, *Cognitive Architecture: Designing for How We Respond to the Built Environment*, 58.
- 09 Ibid., 128.
- 10 Ibid., 24.
- 11 Ibid., 26.

## THE NEIGHBOUR

For this typology, the neighbour is thought of as the social support needed in such a sensitive time. The goal of the room is to provide an architecture that could support changing qualities required by the mother; however, the mother also needs space to welcome social interactions — resulting in the final layout being able to morph alongside other rooms. As mentioned in the earlier chapter, the adjacencies between neighbours strategically had interstitial space between them. On one side, the extension of a waterbirth tub; the other, to host social interactions either in a private, semi-private, or semi-public setting (depending on each neighbour's stage).

Once deciding the program between the rooms, it was how other women and support staff could access the area that furthered the design of a flexible program. For the shared social space, the mirroring entrances form a nook to allow space for its door. This door remains closed when neither neighbour requires it (i.e., both in Stage I), or only one of them needs it (i.e., Stage IV used to host family during labour). In a situation where there is a conflict, the more crucial stage will outweigh the other (i.e., Stage V and Stage III, both vigilant but V more associated with a social program). When this happens, access from the hall is possible as well as entering into their room through the kitchen. When laid out together, the assortment of stages develops a flexible building layout with many scenarios [57].

As the rooms next-door determine the interstitial space, it is the connection to occupants within the building from views that develop the courtyard program. By mirroring the developed floor layout, connections occur between neighbours when a view opens due to its corresponding stage [55]. Views were also expressed in section to show how multiple levels could work with a vast topography of Bell Park [56]. In section, it was apparent to keep fixed program grounded while flexible above. This arrangement allows, when the stage permits it, that the mother can watch programs that promote a quality (i.e., a cafe being a slow pace, while a trail expresses movement and activity).

To think of the neighbour, before the entirety of a building, allows the opportunity to design for a pregnant women's needs at all scales. The fixed program of the building will soon conclude this typology.



STAGE I [WEEK 4 - 13]		
Light		Reflective/ Low Lux
Motion		Slow / Unison
Proportion		Connect Body / Acoustics Dampened
STAGE II [ WEEK 13 - 26]		
Light		Well-Lit / Direct
Motion		Fast / Disorder
Proportion		Connect Body / Acoustics Heightened
STAGE III [WEEK 26 - 29]		
Light		High Lux / Direct
Motion		Fast / Disorder
Proportion		Disconnect Body / Acoustics Heightened
STAGE IV [WEEK 30 - 40]		
Light		Well-Lit / Reflective
Motion		Slow / Unison
Proportion		Connect Body / Acoustics Heightened
STAGE V [WEEK 40 - 6 POSTPARTUM]		
Light		Well-Lit / Reflective
Motion		Fast / Disorder
Proportion		Connect Body / Acoustics Heightened

With the initial stage only having a fixed view by the bed, the view would be best to not connect people but with nature, to assist her in feeling relaxed<sup>01</sup>. Therefore, this view made it crucial to be strategic in the development of a landscaping plan for foliage.

The adjustment of this stage was the kitchen window being available. This view would still benefit from nature, however, with it being wider than the bedroom window, the view can connect the movement of people through trails.

At this time the wall behind the bed moved forward to offer a panoramic view. To stop the mother from being overly vulnerable, the strategically planted foliage (required for Phase I) can shelter her. However, due to the width of the view, there are many points of focus to bring a disordered quality<sup>02</sup>.

For the stage before pregnancy, the window behind the bed is returned, and the interstitial social space is available. When within the room, the mother can look down and relax to programs below that are associated with her stage (i.e., prenatal classes hosted outside). Her positioning will start a “nesting effect” as she feels safe in her surroundings before labour<sup>03</sup>.

This last stage is similar in the qualitative experience of Stage IV except the movement is suggested to be faster and disordered. Since the view from the interstitial social space is the same, this is accomplished by having its door open to the corridor to allow occupants in the hall to interact with her. Having two points of focus within the space makes the mother more vigilant of her surroundings.

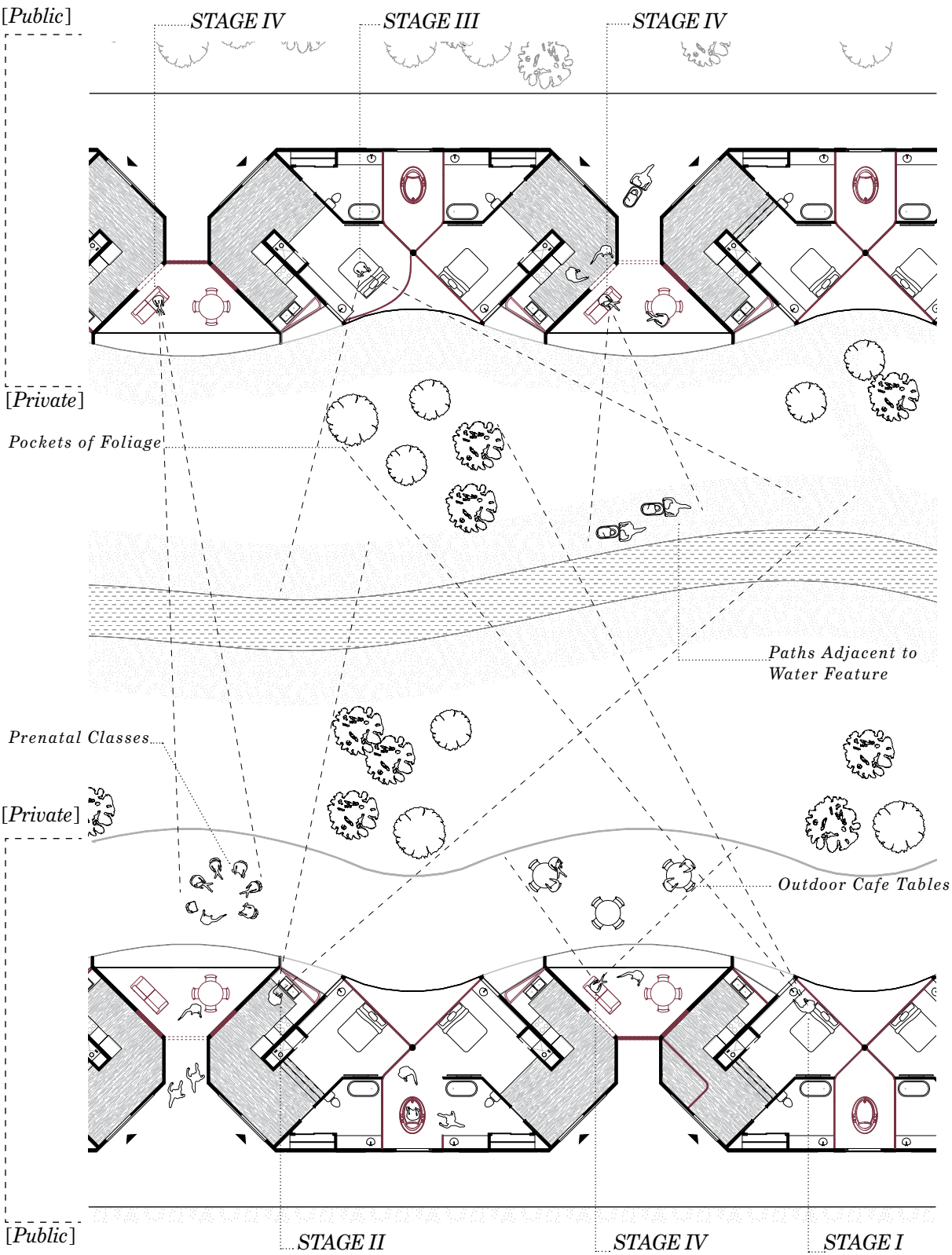


FIGURE [55]  
Schematic drawing of floor plan to show the interactions of multiple stages interacting with flexible and fixed program.  
1 : 600

[Public Realm]

The corridors have been orientated for either the public trail or street to have movement parallel with it. This way during Stage I there is less of the distraction of the view on the one side of the single-loaded corridor.

[Private Realm]

The residences are orientated to face the public realm because of the ability to start to become familiar with other faces in the building. As well, having a semi-private outdoor space.

Public Realm

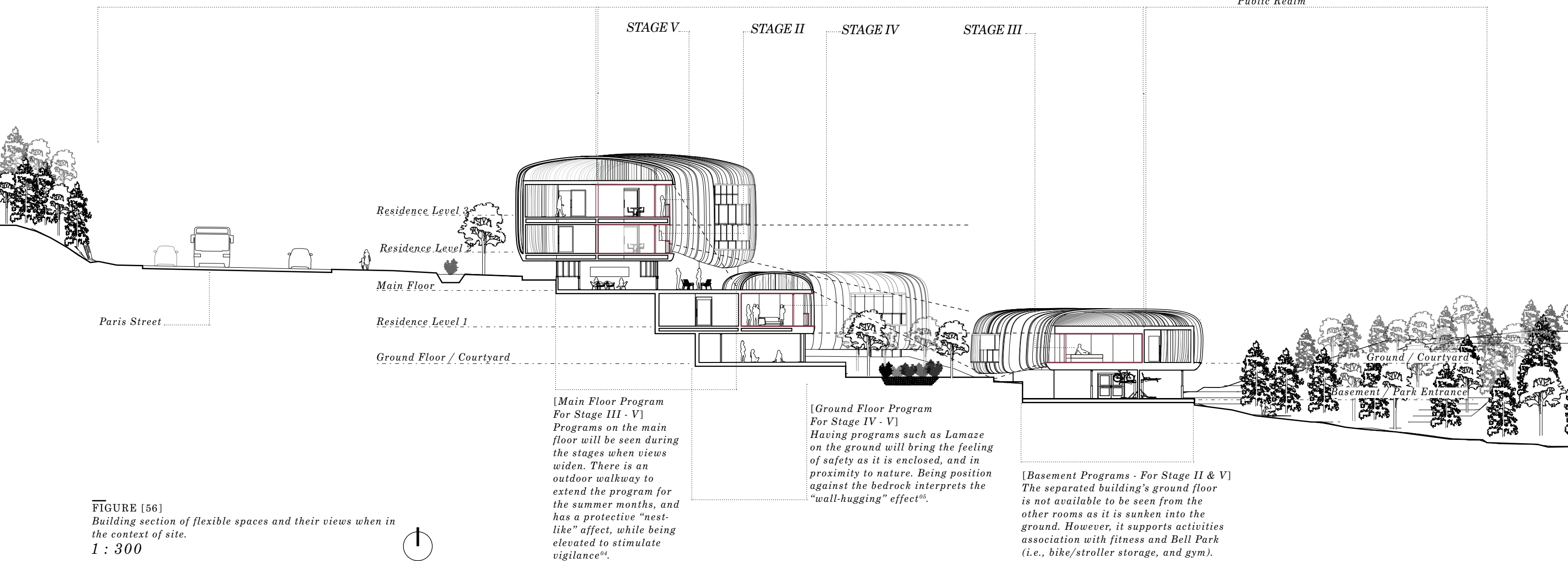
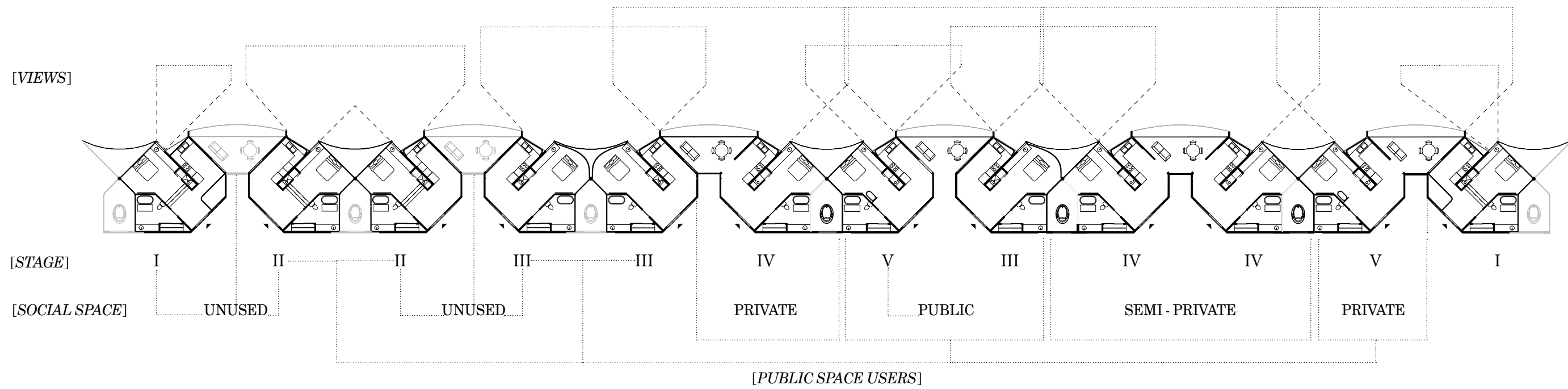


FIGURE [56]  
Building section of flexible spaces and their views when in the context of site.  
1 : 300



FIGURE [57]  
The development of a building floorplan with multiple stages responding to their neighbours and the views.  
1 : 800





## ENDNOTES

- 01** Kellert, S., J. Heerwagen, and M. Mador (eds.), *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*, New Jersey: John Wiley & Sons Inc., 2008, 1-7
- 02** Ibid., 1-13.
- 03** Pearse, Innes H., and Lucy H. Crocker, *The Peckham Experiment: A Study of the Living Structure of Society*, Edinburgh: Scottish Academic Press, 1985, 155.

## AN OBSTETRICAL TYPOLOGY

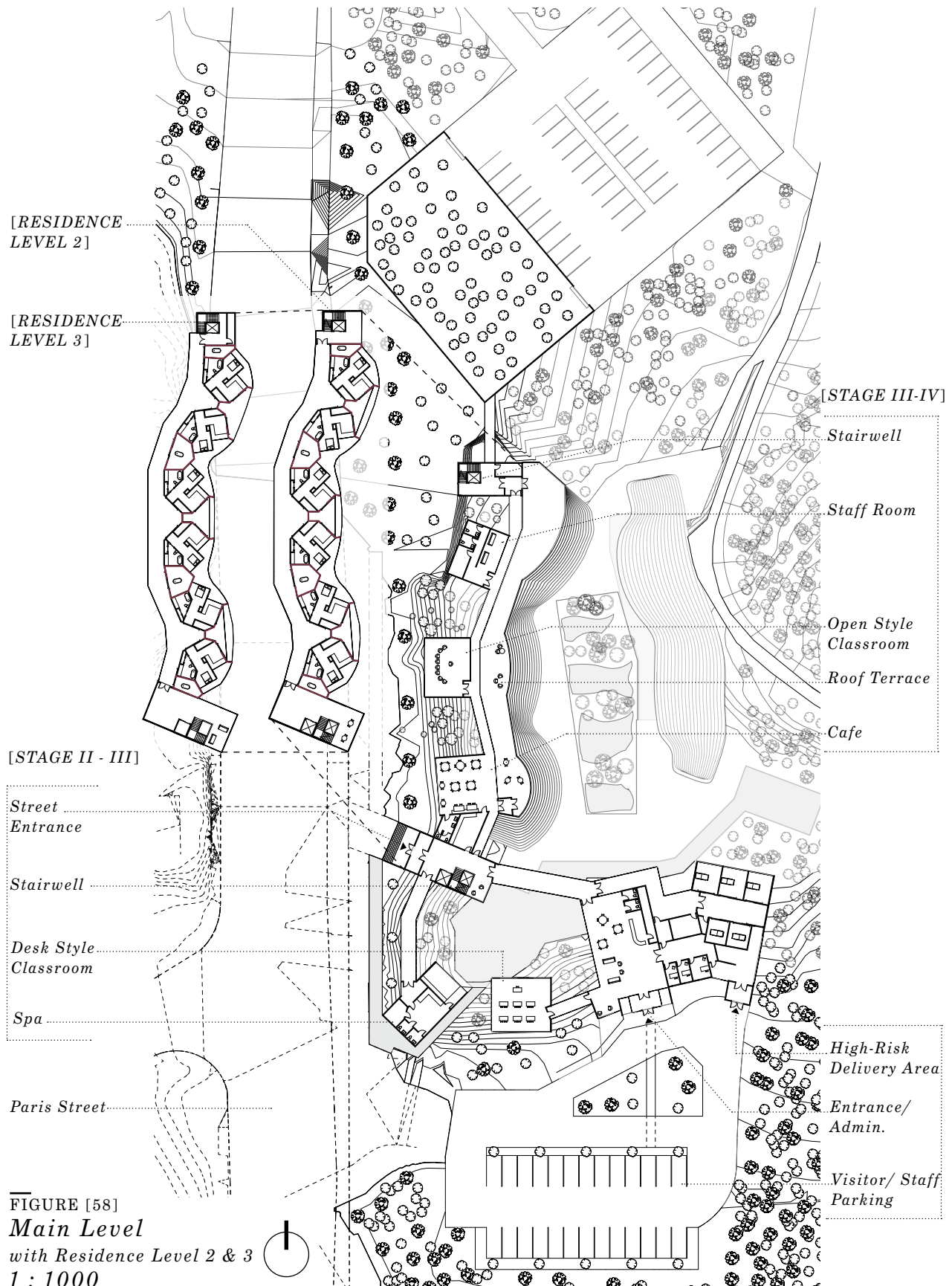
The final stage in developing this new typology is to complete the layout of its associated program within the site context. The guidelines followed when configuring rooms together through plan and section include fixed program grounded with a flexible residence above; a courtyard condition with strategic landscaping; using the bedrock as a “wall-like” condition; single loaded corridors to face the street/path; residences to face the private courtyard. These guidelines when paired with the previous research helped to conclude a final building layout [58].

### *MAIN FLOOR*

Starting on the Main Floor, that is used as a fixed program level, the main entrance is located on the south side where there’s an existing parking lot and intersection. The building mass wraps around the excavated earth leftover from the demolition of the rest of the former St. Joseph’s Hospital. The Main Floor is for the fixed program since it is grounding the flexible spaces above (Residence Level 2 & 3). The Main Floor’s massing is broken up into islands to allow view and natural elements (i.e., water, animals, plants) to cut through the site - in doing so promoting well-being through biophilic elements<sup>01</sup>. The connecting glass corridors link each of these massings. This level’s fixed program includes classrooms, spa, cafe, staff space, and the admin/high-risk delivery area, as well as a mass to support the vertical connection between levels. The cafe and classroom have an adjacent roof terrace to extend their program outdoors. Although these programs are fixed, they still have architectural qualities for the stages they are catering too. These programs are for Stages III and IV as it is for prenatal classes, and places to sit and socialize. At this elevation, it is clear to look over the treeline and see Bell Park and Ramsey Lake. Although these programs were specified for Stages III and IV, this does not mean they are off limits to women in other stages but means that the fixed architecture would reflect the appropriate qualities.

### *RESIDENCE LEVEL 2 & 3*

The residences above the Main Floor are flexible programs and were described in the previous chapter. Stairwells and elevators have been added on each end for circulation of the woman and staff. These two floors face Ramsey Lake and look down on the courtyard and the Main Floor’s roof terrace.



*RESIDENCE LEVEL 1*

Beneath the mentioned roof terrace is another Residence Level that is in closer proximity to the courtyard [59]. The layout is the same as the other residence levels but has a connection to a private enclosed parking garage; which is within the former St. Joseph's Hospital's footprint. Having sheltered parking was strategic as during the winter months it would be easier for those later in term to access their vehicle. There are unsheltered parking spots for the public attending Bell Park. As for the positioning of this level, the elevation allows views over the building to the east and the treeline. Views onto the courtyard area are available during Stages IV and V. Now that the street above is no longer in sight to run parallel with the corridor, another strategy is used. Light is filtering between the island massing and gives contrasting moments of light and darkness. These comparative qualities are known to promote phototropic behaviours that move people forward<sup>02</sup>. The spaces in-between the massings have been developed as bioswales to allow water to flow

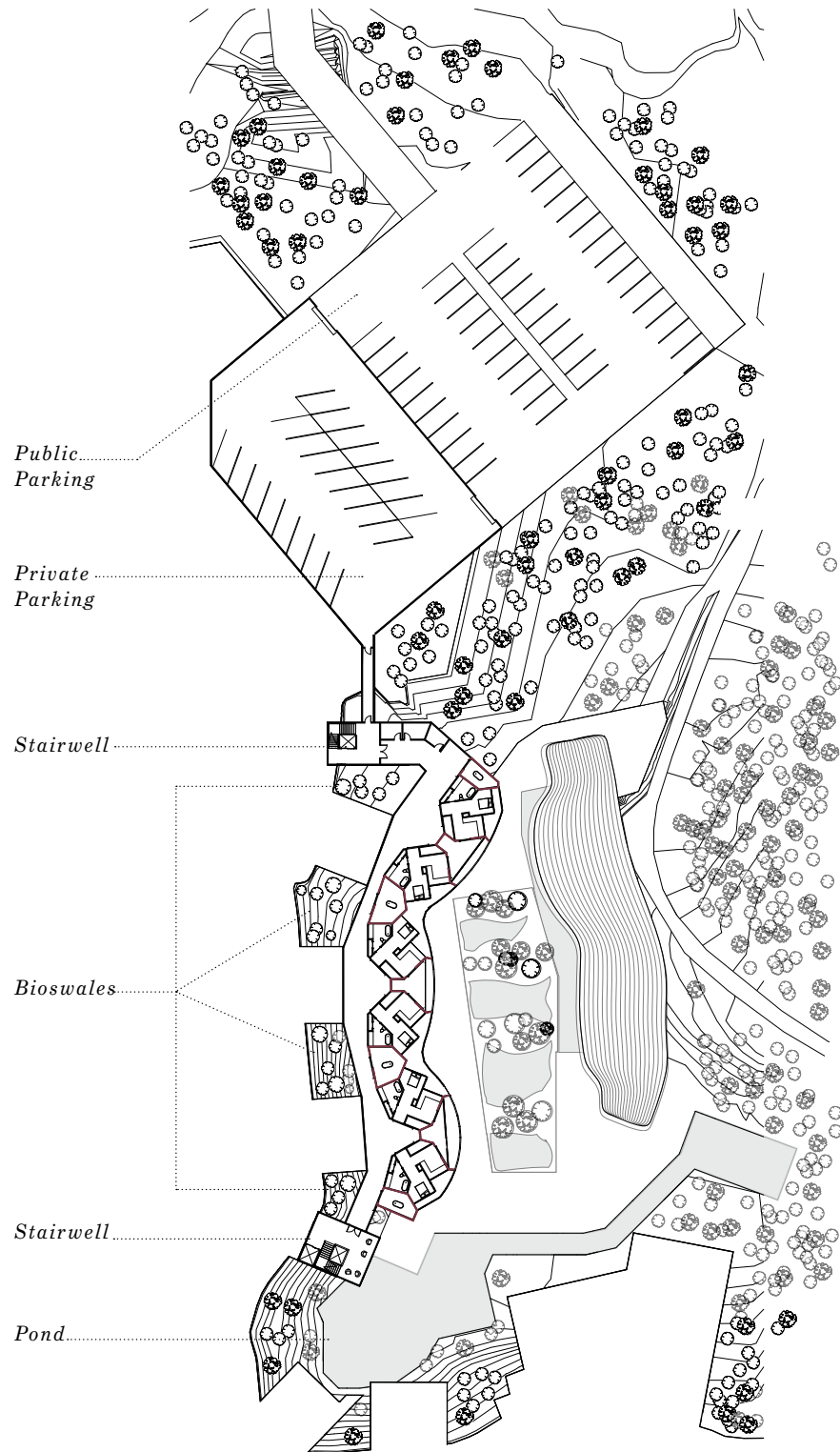


FIGURE [59]  
*Residence Level 1*  
1 : 1000



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**GROUND LEVEL /  
COURTYARD**

through the site.

The Ground Level is the foundational massing for Residence Level 1, and has access to the courtyard [60]. Like that of the Main Floor, this level is for the fixed program and caters primarily to Stages IV, and V. These include a Lamaza space and breast-pumping station. These programs benefit from being at ground level because the geological landscape establishes a rootedness in place; promoting well-being<sup>03</sup>. Lamaze can be extending out into the courtyard during the warmer months; at this time the residence levels above can oversee the activities. The landscaping of the courtyard is strategic to orientate Stage I's view of nature, as well the incorporation of the bioswales that connect the street level to a filtration pond. The use of incorporating water through the site is a useful architecture feature to trigger various qualities (i.e., movement, clarity, temperature, and sound). Therefore, the flow from the collection of water will work parallel with physical activity for Stage II, and whose view overlooks the area.

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**BASEMENT/PARK  
ENTRANCE**

The last level is a foundational massing for the east building. The views to its fixed program are different from that of Main Floor and Ground Floor because it is partially sunken into the earth; disconnecting the line of sight. Although not visible for Stages II and V, the program supports the stages for physical activity and Bell Park. Programs include a gym and storage for bikes and strollers.

---

**ENDNOTES**

- |           |  |
|-----------|--|
| <b>01</b> | Kellert, S., J. Heerwagen, and M. Mador (eds.), <i>Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life</i> , New Jersey: John Wiley & Sons Inc., 2008, 1-7 |
| <b>02</b> | Alexander, Christopher, and et., <i>A Pattern Language: Towns, Buildings, Construction</i> , 645.  |
| <b>03</b> | Kellert, S., J. Heerwagen, and M. Mador (eds.), <i>Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life</i> , 8   |



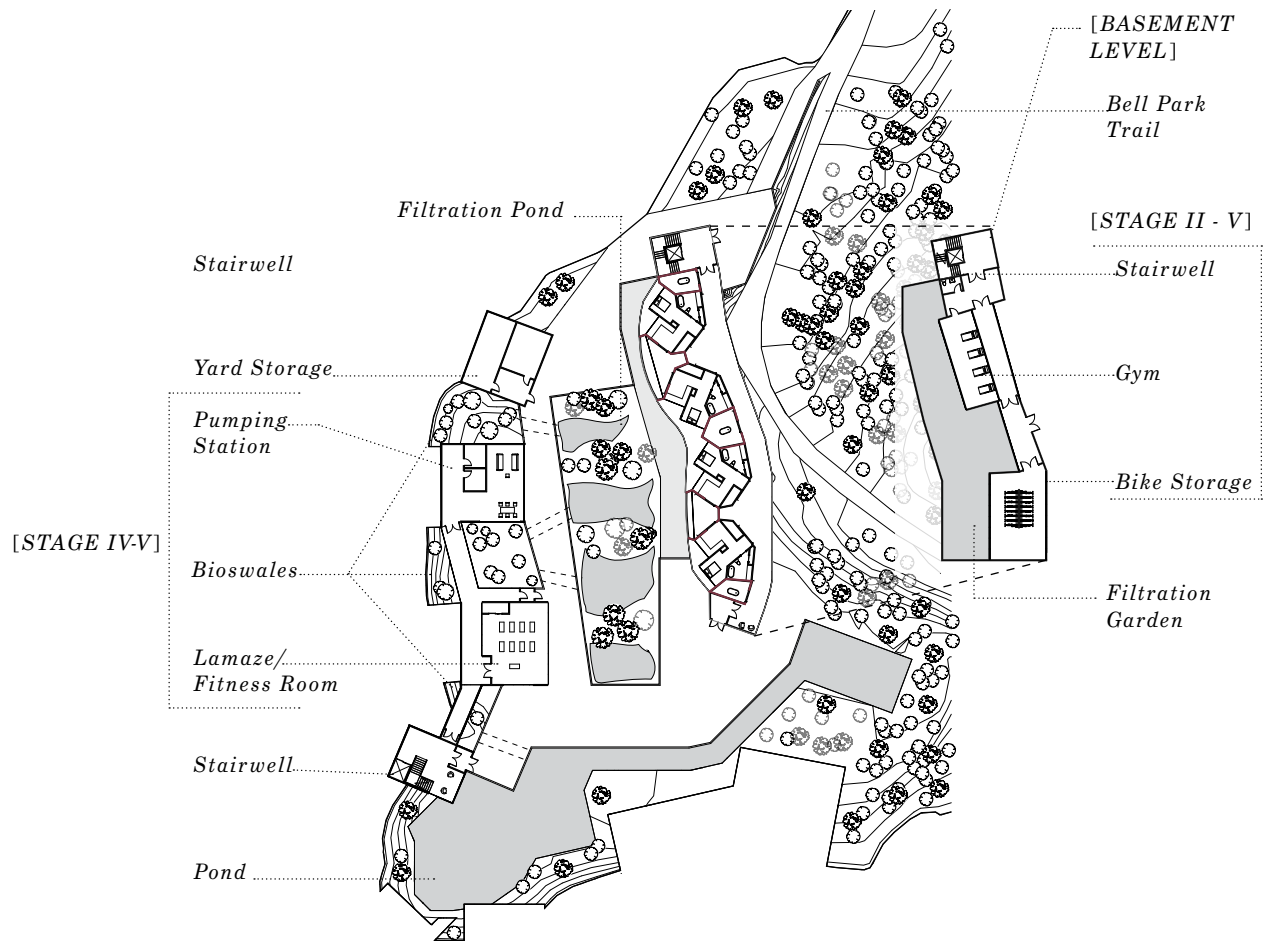


FIGURE [60]  
Ground Level / Courtyard  
with Basement Level  
1 : 1000



## THRESHOLD INTERFACE

This new typology for an obstetric program is designed to look at the micro changes within the mother's body and have the architecture she is exposed to support it. A data collection and sensing device coupled with artificial intelligence (AI) are in pairing with this typology in order to make the interchange between the scale of micron to millimeter possible. This idea should be thought of as a "threshold between scales." This idea is not new, as this threshold is already seen naturally within the mother's body. At approximately 18-20 weeks, the placenta is fully developed and secretes hormones for the fetus (taking the stress off the mother's corpus luteum), and gives fuel and takes waste from the fetus (i.e., nutrients, oxygen, and carbon dioxide)<sup>01</sup>. The placenta does this process from diffusion. To explain, the basal plate (belonging to the mother) and the chorionic plate (belonging to the fetus) are never in contact, but they both use the intervillous space to interchange molecules and bacteria between them<sup>02</sup> [61]. The intervillous space acts as the threshold, just as the relationship between the mother and the architecture

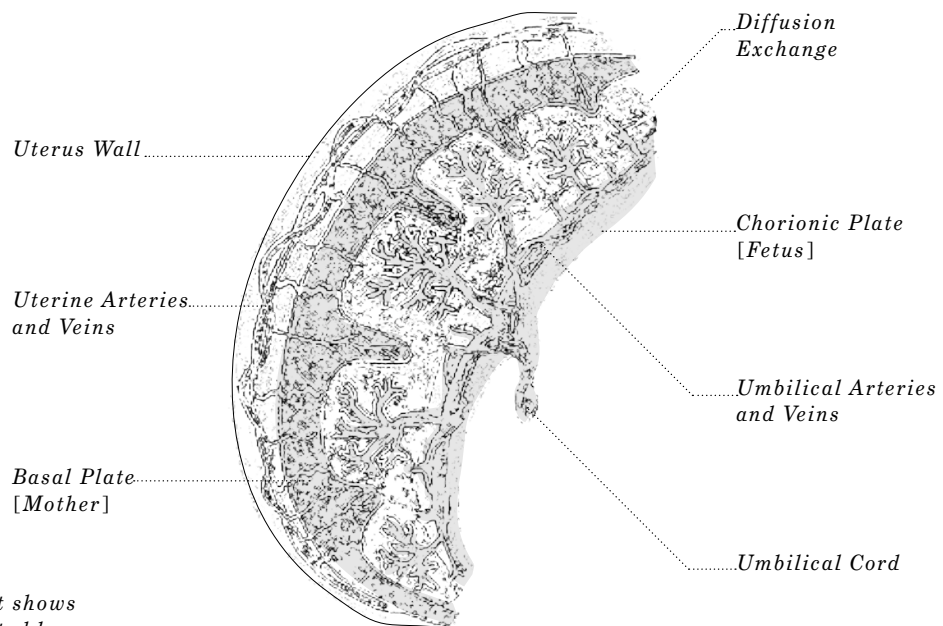


FIGURE [61]

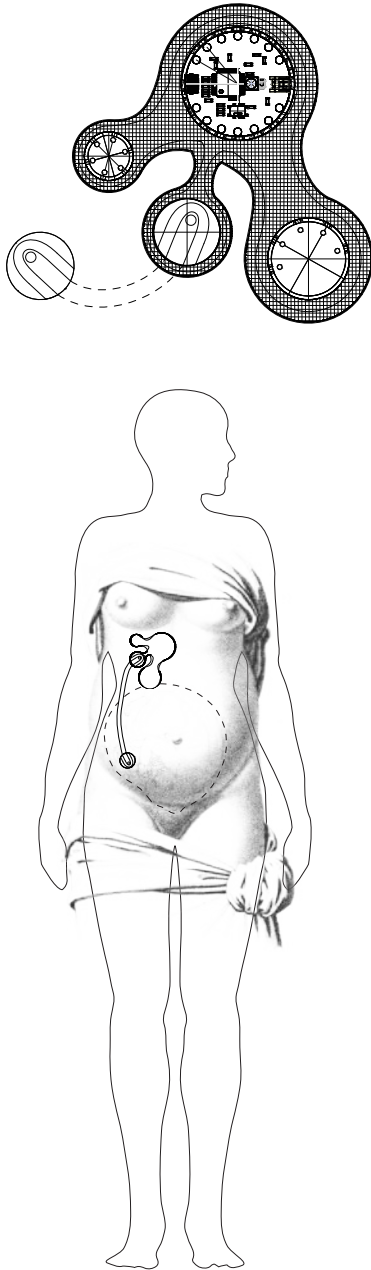
Diagram of the placenta that shows mother and fetus are separated by the area for diffusion exchange. Interpreted and illustrated by author.

would work. Like the placenta, the interface for this threshold may be aware of one user's exchanges and may require the architecture to move sooner or later than the previously stated pregnancy timeline. This awareness will allow the architecture not to force a hormonal exchange when not needed by supporting the natural rhythms of her body.

However, as there are multiple users within the overall program, *how would multiple user interfaces work?* When referring back to natural phenomena, one placenta does not mean one fetus. In the occurrence of identical twins (monozygotic, developed from one zygote into two embryos), during their fetal development, they use a single placenta (monochorionic)<sup>03</sup>. The process of diffusion works the same for each twin, but on the placenta, there is a vascular equator for the meeting of the twin's arteries<sup>04</sup>. The placenta will communicate what each twin may need at each time, making it a shared threshold but for individual users. This example will be the theoretical framework for the interface as mothers interact with one another. As more women use the program and interact with one another, the deep-learning algorithms (AI) will pick up patterns of who is adjacent to who (as seen in shared interstitial spaces) and the overall occupancy of the building. The interstitial spaces have qualities that may be essential to one mother (or one twin) over the other. The embedded AI model within the interface will pick up on both, and ultimately decide the best scenario between the users. As the program is at full occupancy, the entire building becomes a living organism that becomes aware of not only the interchanges within one room but where the next interaction might happen. This awareness assists the support staff as they are preparing the shared programs. It has been a prominent problem in existing parturition institutions that the occupancy is an issue as the rotation of labour, delivery, and recovery becomes more of a factory line<sup>05</sup>. Having a typology that synthesizes on the overall statistical data will show evolving patterns that would help an overload. More importantly, synthesizing on the overall occupancy will show how Darwin's "fitness"<sup>06</sup> (within the population of Sudbury) is benefitting from taking care of well-being before birth. As this typology is anticipated for future health care, artificial intelligence will assist in proving how vital the maternal environment is.

As innovative as AI may be, there is a possibility of conflict between mother and the architecture that would require her to override the system. The architecture, as mentioned prior, is only assisting the natural timing of pregnancy not forcing it. Its assistance does not take into account an individual's preference at a particular time (i.e., physical activity during Stage I, when it is discouraged). Constraining a mother's choice will only make negative interchanges within her body<sup>07</sup>, and will go against the entire proposal of this thesis. Therefore, the override is required within the interface and will allow the mother to change not the architectural qualities, but the once off-limits programmatic and interstitial spaces. By not changing the architectural qualities (i.e., lighting and proportion), there is an atmosphere that will remain and contribute to the mother's perception. Giving her the option to be involved in closed-off spaces will enlighten her to use the entirety of the centre. As well, this will allow her to feel in control of space and control of her pregnancy. Since the mother is allowed to visit any room regardless of her stage, *why close-off specific rooms at all?* Having rooms appear closed off is only a suggestion for her to visit other programs that are encouraged for her (i.e., Stage II encourages walk and talking for interaction, versus sit down exchanges). To allow the mother to be as aware of her chemical changes, when a mother requests to enter a space the interface will be aware of her choice and will display her current stage next to the door/frame she is entering. She can see what her current stage is and compare that to the rooms suggested stage. There would be no green or red light to state if the choice were good or bad, as that only guilts the mother and any free-will choice by her is welcomed regardless<sup>08</sup>. Instead, she is more in tune with her current status. If the architectural qualities of that space she enters is not preferred (because not her current stage), she will possibly leave on her own accord.

The second occurrence where a mother will visually see her current hormonal stage is during check-ups with her OB or midwife. These appointments are standard already, however having the interface live with medical notes recorded by the doctor, will bridge the digital and analog components of medicine. Since each room was designed to host the check-ups (and eventually the birth), so has the display of the interface. The rooms have their own hidden medical equipment



supply (i.e., ultrasound and sanitation wipes), as well as a television that the support staff can use to show the fetal and maternal well-being. Displaying both information shows the partnership between a mother and child, and how the architecture has benefited the development of life so far.

In order to initiate the AI, a sensing device is needed to connect the mother to the interface within the architecture. This device is called “The Womb Wrap,” and it is a wearable medical instrument that will be worn by the mothers [62]. Made from stretchable materials that wrap around her expanding abdomen, the device will gather bio-indicators from embedded sensors (i.e., hormone levels, temperature, and maternal/fetal heartbeat), as well as an accelerometer for her location and orientation. Most of the sensors are embedded in wearables and handheld devices today, except for the hormone sensor. A woman’s hormones samples are gathered from urine and blood samples that are taken throughout her pregnancy; to make sure the fetus has developed correctly. Unless she has been administered to the hospital, these hormonal readings are not frequent. This proposed sensor will need to take blood samples from the mother and upload in real-time to the interface. As this sounds currently invasive, the sensor’s design is from an insulin port/pump that is used by people with diabetes. Insulin is a peptide hormone and needs to be monitored regularly for type 1 and more severe cases of type 2 diabetes<sup>09</sup>. This shows that even today the medical hardware and technology is available for such a device. The collection of this information from the bio-sensors within the device is sent to the programmed hardware and uploaded to the residence’s interface (over Bluetooth) to make the appropriate changes. This medical tool acts as one of the sides of the placenta plate before the diffusion of interactions between mother and child, except it will be between the mother and the architecture.

FIGURE [62]

*The “womb wrap” is the data collecting and sensing device that will be worn by the mother in order to connect a threshold between her hormones and the architecture.*



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- 07 Arms, Suzanne, *Immaculate Deception: A New Look at Women and Childbirth in America*, Boston: Houghton Mifflin Company, 1975.
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## CONCLUSION

*“What influence does the built environment have on us, the human species, in our evolutionary development?”*

The process of investigating a new typology for pregnant women, was a journey that started at the cellular level of epigenetic tags. Hormones are associated to emotional outputs that are triggered by the experiences in the outside world, resulting in the turning on and off of these tags<sup>01</sup>. As this may result in inheritable disorders, there are influences that our built environment has for our future generations. Through the gathering of research of multiplicities and connections it became over bearing on the possible input and outputs for understanding architecture’s role. Enlightenment came when only focusing on the most significant architectural qualities of a specific hormonal occurrence; allowing this rhizome to turn into a tangible project. Concluding that even a small discreet change in an architectural space could be beneficial for our well-being in the long run. If an architecture could read the measures we perceive, this would change civilization and the role designers have. Looking past the design process and to the typology itself, it is clear that the maternal environment is overlooked in the complexities of program. There are different building types for these programs, with a main focus on parturition<sup>02</sup>. However, there are no examples of an architecture that caters to all of these programs, including the most crucial space for pregnant women; the home<sup>03</sup>. For those women who do not have a home that provides the feelings of safety and comfort, it is not suitable for them to reside there. This typology would be positive to the mother, her child, and her grandchildren. The initial design question was answered by the in-depth analysis of cross referencing the fields of design and medicine. However, this typology requires the bridging of thresholds to allow an architecture that responds to cellular signals. When designed with the intention of an artificial intelligence, it changes the idea of a “morphing architecture” into an “evolving architecture.” This innovation is an example of how we promote human fitness within the built environment.

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01

02

03

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